SURGERY, GYNECOLOGY AND OBSTETRICS

AN INTERNATIONAL MAGAZINE, PUBLISHED MONTHLY

VOLUME XV SEPTEMBER, 1912 NUMBER 3

# RESULTS OF THE PERMANENT INTUBATION OF THE THORACIC AORTA[1]

BY ALEXIS CARREL, M. D., NEW YORK CITY
From the Laboratories of The Rockefeller Institute for Medical Research

TWO years ago I had the honor to describe before the American Surgical Association some experiments which were made with the view of finding a radical treatment for intra-thoracic aneurysms. I had succeeded in grafting on to the descending aorta of a dog a segment of vein preserved in cold storage. The animal remained in good condition, and died a few months ago of a myelitis which was then epidemic among our dogs. The descending aorta was found to be in normal condition. Although the operation had been performed more than two years previously, there was no dilatation of the transplanted segment. The internal coat of the vein was white and glistening. There was no stenosis or dilatation at the level of the anastamosis. The valves of the transplanted vein had remained normal. (Fig. 1.) The venous wall was composed exclusively of connective tissue. It was then demonstrated that a normal circulation could take place for more than two years through a vein grafted on the descending aorta.

In the actual conditions of surgery, the resection of the sac and the graft of a vascular segment on the thoracic aorta would be a complicated and dangerous operation. It would be simpler to insert into the sac a gold tube through which the blood could flow. The idea of introducing a tube into the lumen of a vessel is not original. Paraffined glass tubes are used in all physiological laboratories for securing artifical circulation of blood. The same method has been applied successfully by Brewer to the transfusion of blood in human beings. Some years ago Abbe united the cut ends of the femoral artery of a dog by means of a glass tube. He found afterwards that the tube was free in the dilated end of the artery, and that slow endarteritis had sealed it below. He also cut the abdominal aorta of a cat and inserted into the ends a very thin glass tube. The cat made a perfect recovery, was presented after four months at the Academy of Medicine, escaping afterwards. In this experiment the time of the occlusion of the tube was not shown, because, in a cat, a slow obliteration of the abdominal aorta does not interfere with a perfect condition. In another experiment, made by Dr. Dunham and Dr. Cushman on a large dog, a tube inserted in the abdominal aorta did not become occluded for two days. Abbe thought it would be feasible in a case of aneurysm to split the aorta and to tie a tube in either end of the sound artery, and that a slow obliteration would go on while the collateral circulation would increase and become adequate after a short time.

In these experiments, the tube became slow-

[1]Read before the American Surgical Association, Montreal, May, 1912.

Fig. 1. Transplantation of a segment of vein on the thoracic aorta of a dog. Specimen extirpated two years after the operation.

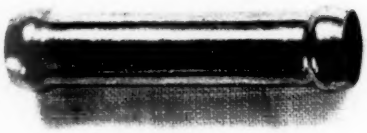

Fig. 2. Aluminum tube.

ly obliterated. It seemed, therefore, that a foreign body could be put into a vessel temporarily without accident, but that thrombosis would occur sooner or later.

Nevertheless, it was conceivable that thrombosis was due to a preventable cause, and that the conditions under which a foreign body could be used for the separation of a vessel were within our reach. It was attempted, therefore, to extirpate part of the anterior wall of the abdominal aorta of a dog, and to replace it by a piece of rubber covered with vaseline. Fifteen months after the operation, the circulation was still normal. The vessel wall had reproduced itself inside and outside the rubber. It was found also that the circulation could take place during six days through a paraffined glass tube free in the abdominal aorta, and that the obliteration which occurred afterwards was due to the displacement of the tube.

Encouraged by these results, I attempted to develop a technique by which the operation could be made successful and safe.

The operations were performed on the thoracic aorta of middle-sized dogs. The thoracic cavity was opened on the left side, under ether anæsthesia (Meltzer and Auer method).

1. Silk compresses sterilized in vaseline were introduced in order to protect the left lung and to wall off the pleural cavity. Then a Gosset retractor was placed between the ribs. Another silk compress was introduced into the cavity in order to circumscribe exactly the field of operation.

2. The pleura was cut along that portion of the aorta which was to be intubated, the aorta itself was not dissected, nor its collateral branches ligated. Two ligatures of soft, heavy, silk thread were passed around the aorta, approximately at the points where the ends of the tube were to be fixed. A few centimeters above and below those two ligatures, two elastic forceps were kept ready for clamping the vessel. The elastic blades of the forceps were applied directly on the arterial wall without rubber. (Fig. 3.)

3. The wall of the aorta was then cut longitudinally. The edges of the incision were caught by two forceps and the tube introduced in the lumen of the aorta. Straight tubes of glass, aluminum, or of gold-plated aluminum were employed. Their diameter was generally nine or ten millimeters, while their length was forty-five millimeters. As the dogs were of various sizes, the tubes distended, exactly fitted the aorta, or were of relatively smaller caliber. The edges of the metallic tubes had the shape represented in the photograph. (Fig. 2.) The glass tubes were made in a crude way, and their edges were often uneven and too sharp. Before being used, the tubes were paraffined.

As soon as the tube was introduced into the lumen of the vessel (Fig. 4), the silk threads which had been previously put around the aorta, were tied. These ligatures should be tied tightly enough to prevent the tube from slipping, but not too tightly; there is danger of cutting the aortic wall, which has been found to be very friable.

4. The clamps were removed and the circulation re-established through the intubated segment. (Fig. 5). There was generally no hæmorrhage from the opening in the aortic wall. In some cases the opening was not closed. In others it was sutured with fine silk. The pleura was then sutured along the

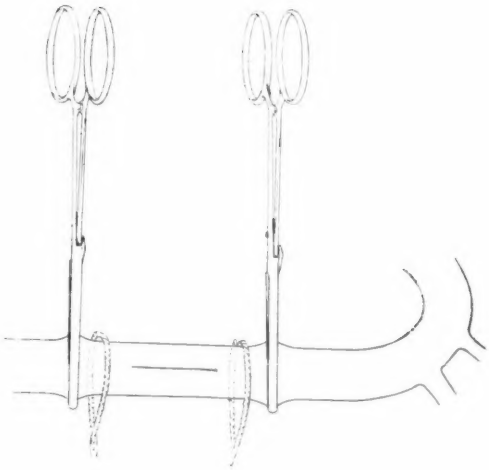

Fig. 3. Temporary preparation of the ligatures and incision of the wall.

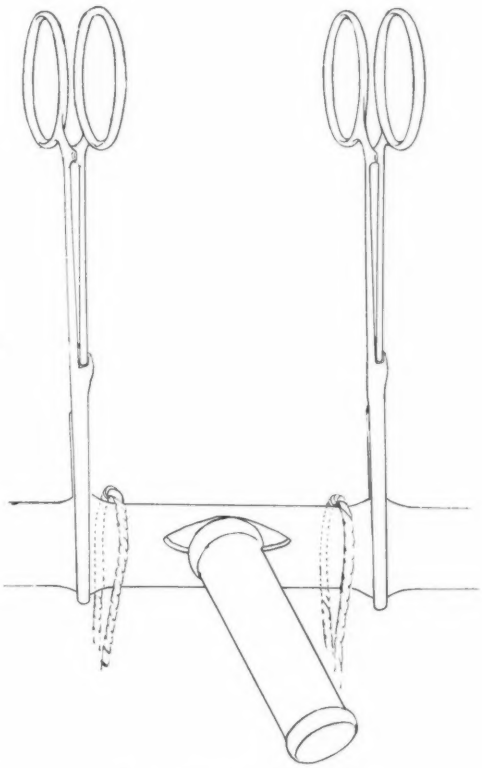

Fig. 4. Introduction of the tube.

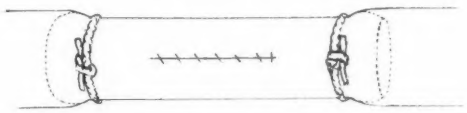

Fig. 5. Operation completed.

aorta. The silk compresses were removed, and the ribs approximated by two silk ligatures. Then the muscles were united by continuous sutures. Before closing the thoracic cavity, the trachea was slightly compressed in order that the lungs might regain their normal size. The closing of the thorax was then completed by several planes of sutures.

Eleven experiments were performed. In one case, the introduction of a tube into a comparatively small aorta resulted in tearing of the wall, and the animal was immediately chloroformed. The results obtained in the ten other cases will be briefly stated.

The thoracotomy under anæsthesia by the Meltzer-Auer method, and the handling of the thoracic aorta were not dangerous. No post-operative pleurisis or other complication were observed. During the first week following the operation nearly all the animals remained in excellent condition.

Seven animals were intubated with a glass tube, three with an aluminum tube, and one with a gold-plated aluminum tube.

Two of the animals intubated with a glass tube died of hæmorrhage eight days and eleven days after the operation. The accidents were due to preventable causes, the cutting of the aortic wall by the ligatures, and the breaking of the tube. It was found that no clot had deposited on the wall of the tube. In the five other cases, obliteration of the aorta or of the tube occurred suddenly from five to ninety-seven days (Fig. 6) after the operation. The tube or the aorta were found to be occluded by a fresh thrombus, which, in every case, started from a laceration of the

Fig. 6. Dog in a normal condition, ninety-five days after the intubation of the thoracic aorta.

wall due to the poorly finished upper or lower edge of the tube. It appeared that thrombosis did not take place as long as no laceration of the vascular wall occurred. The form and the size of the tube in a large measure seemed to be responsible for this complication.

In two cases, aluminum tubes were used. The shape of these tubes was very much better than that of the glass tubes, but corrosion of aluminum resulted. One of the animals died suddenly twelve days after the operation. The tube was found corroded. Its lumen was obliterated by a thrombus, and the intubated part of the aorta was very much thickened. In the other experiment the animal remained in excellent condition for more than fifty days. He died rather suddenly fifty-five days after the operation. Both pleural cavities were filled with a clear hæmorrhagic fluid. Around the intubated portion of the aorta a large tumor was found, adherent to the posterior thoracic wall. The tumor was composed of granulation tissue, in the center of which the aluminum tube was located. The tube was corroded and partially occluded by a deposit of fibrin. In both cases the complications would probably have been prevented by the use of tubes made of gold instead of aluminum. In the tenth experiment, the aorta was intubated with a gold-plated aluminum tube of comparatively small caliber. Corrosion of the tube occurred and the animal died.

These experiments have shown a new fact: The arterial blood flowed through a glass tube nine or ten millimeters in diameter during periods varying from five to ninety-seven days. No deposit of fibrin on the wall of the tube occurred. Sudden occlusion of the vessel or of the tube took place following a laceration of the aortic wall by the roughly finished edges of the tube.

The permanent intubation of a large artery is a simple operation. It may become practical if the shape and the nature of the tubes be modified in such a manner as to prevent the laceration of the aortic wall. It is probable that the use of smooth-edged gold tubes, or of tubes lined with a vein, will be followed by better results. The question of the application of this method to human surgery will then, possibly, be considered.

# CENTRAL DISLOCATION OF THE FEMUR[1]

By GEORGE TULLY VAUGHAN, M. D., Washington, D. C.

SOME confusion seems to exist as to what constitutes a central dislocation of the femur. While some would include under this heading all cases of fracture of the pelvis in which the head of the femur passes into the pelvis, others would limit the term to special cases in which the fragments of the acetabulum bear a certain relation to the head and neck of the femur. It would seem then that a central dislocation of the femur is a fracture dislocation in which the head of the femur passes through the floor of the acetabulum into the pelvis, the ring or rim of the acetabulum embracing the neck of the bone. The floor of the acetabulum is always broken, and the ring is also probably always broken or cracked so that the parts may temporarily separate from one another in order to let the head pass through, but the fragments must still be in position to make more or less of a ring, which embraces the neck of the femur.

Intrapelvic dislocation is not necessarily of the central variety. A fracture of the pelvis which permits the acetabulum to be pushed into the pelvis by the head of the femur is not a central dislocation, nor is an injury in which the head of the femur is in the pelvis but the fragments of the acetabulum are displaced some distance from the femur. At times, in central dislocation, the fragments of the acetabulum separate along the lines of their embryonal origin enough to permit the head to pass through, and then close together around the neck.

In collecting the reported cases I have followed Müller's plan of dividing them into the "clear cases"— those in which the diagnosis was confirmed by undoubted signs, by necropsy, by the Roentgen ray, or by operation; and the "doubtful cases," in which the diagnosis was not proved. To Müller's list of twenty clear cases I have added six, including my own case; and to his list of twenty-nine doubtful cases I have added ten cases, as shown by the table.

CENTRAL DISLOCATION OF THE FEMUR

*Clear Cases.*

1. Arregger ..... 1904
2. Cooper ..... 1823
3. Grässner ..... 1902
4. Henschen ..... 1909
5. Hutchinson ..... 1866
6. Lendrick ..... 1839
7. Lawson ..... 1878
8. Müller ..... 1909
9. Müller ..... 1909
10. Müller ..... 1909
11. Schloffer ..... 1907
12. Vireveaux ..... 1899
13. Wilms ..... 1904
14. Wilms ..... 1904
15. Woerner ..... 1907
16. Woerner ..... 1907
17. Woerner ..... 1907
18. Woerner ..... 1907
19. Wolff (Rehm) ..... 1907
20. Wolff (Rehm) ..... 1907

Additional:

21. Halstead ..... 1909
22. Schroeder ..... 1909
23. Schroeder ..... 1909
24. Skillern & Pancoast ..... 1912
25. Stocker ..... 1911
26. Vaughan ..... 1912

*Doubtful Cases.*

1. Barron ..... 1884
2. Bennet ..... 1900
3. Beaugrand (Henschen) ..... 1850
4. Böckel ..... 1873
5. Coote (Henschen) 1865
6. Dupuytren ..... 1839
7. Gallez ..... 1899
8. Gama ..... 1837
9. Godlee ..... 1899
10. Hesse ..... 1904
11. Holmes ..... 1887
12. Katz ..... 1902
13. Kilner ..... 1872
14. Krönlein ..... 1882
15. Lauenstein .....
16. Morel-Lavalëe ..... 1851
17. Moore ..... 1851
18. Müller ..... 1909
19. Ohaudjamier (Roux) ..... 1902
20. Paul ..... 1901
21. Peters ..... 1861
22. Rechenburg ..... 1904
23. Samson ..... 1840
24. Sands ..... 1876
25. Simon (von Eiselsberg & Dudloff) 1900
26. Sommer ..... 1907
27. Vaquez ..... 1884
28. Wilms ..... 1904
29. Wilms ..... 1904

Additional:

30. Böckel ..... 1880
31. Bousquet ..... 1896
32. Callisen ..... 1778
33. Faure ..... 1846
34. Fuller ..... 1909
35. Gunn ..... 1885
36. Schroeder ..... 1909
37. Skillern & Pancoast ..... 1912
38. Skillern & Pancoast ..... 1912
39. Skillern & Pancoast ..... 1912

Vaughan's case, 1911: A white man, aged 56, slipped on the street and fell, striking on his left trochanter. He was unable to walk and was carried to the hospital, where examination the following day showed flattening of the left trochanter; otherwise the thigh seemed in its normal position; measurements between the anterior spine of the ilium and internal malleolus gave one-half inch shortening on the left side; motions greatly restricted at hip joint.

A diagnosis of impacted fracture of the neck of the femur was made, but on examining a skiagram, the head of the femur was seen projecting into the pelvis. Under anæsthesia the head of the bone could be felt through the rectum, also irregular surfaces, evidently fragments of bone from the acetabulum. Attempts were then made to reduce the dislocation by traction on the femur outward and downward, but without success as was proved by another skiagram.

Fifteen days after the injury open operation was

[1] Read before the American Surgical Association, Montreal, May, 1912.

Radiogram (not retouched) on admission to hospital May 20, 1911.

Radiogram (not retouched) May 27, 1911, after attempted reduction by manipulation.

done in order to reduce the dislocation. An incision was made from an inch above and within the anterior superior spine along the brim of the pelvis to the femoral vessels, then downward and outward across the neck of the femur. The head of the femur was found projecting through the floor of the acetabulum into the pelvis. Traction was then made by means of a folded towel passed around the inner side of the thigh, downward and outward, while at the same time the head was pressed outward with the hand in the pelvis, but the head would not come out.

An incision was now made exposing the outer part of the shaft at its junction with the trochanter, and the bone was seized where the neck joins the shaft by large bone-holding forceps and strong traction was made, as much as it seemed the bone could bear without fracture, but without success. A strong folded towel was then passed about the femur just below the neck, one end out of the front wound and the other end out of the wound over the trochanter, and strong traction was made with a like result. During these efforts the line of traction was varied and the head was rotated in seemingly every direction. The neck of the femur was now exposed in front and the capsular ligament was opened, showing the rim of the acetabulum apparently unbroken, but on passing a lever through the acetabulum from without over the head of the bone, and prying, the rim of the acetabulum opened and the head easily slipped out into its place. The bone seemed to yield chiefly at the lower front part of the acetabulum. One line of fracture was seen, and this ran from the acetabulum downward and inward obliquely into the pubic bone, but the fragments were not separated. The ring closed as soon as the pressure was removed, and there was no tendency to a recurrence of the displacement on making motions at the joint. The fragments forming the floor of the acetabulum were pressed as nearly as possible into position, the wounds were closed and dressed, and the patient put to bed without any retention or extension apparatus. Suppuration followed and continued for nearly three months, and the patient did not get out of bed for nearly four months. A skiagram taken about this time shows the head of the femur in the normal position.

Six months after the injury the patient was discharged recovered. He was able to walk with crutches, bearing a little weight on the injured limb.

Nine months after the injury (March 16, 1912), the patient can walk with a cane but prefers crutches. All motions at hip possible, but somewhat restricted, evidently from lack of strength. Limbs of equal length. Patient in excellent health. (See skiagrams.)

*Symptoms.* The symptoms of central dislocation of the femur are very similar to those seen in impacted fracture of the neck of that bone.

Radiogram November 13, 1911, following open operation June 3, 1911.

1. Outward rotation of the femur, slight in degree, was noted in eleven cases; inward rotation in one. In some the position as to rotation was normal.

2. Sinking of the trochanter or its approach towards the median line was noted in about half the cases. Measurements are given of a difference of from 2 to 4½ cm. in the two sides.

3. Shortening. As a rule slight shortening existed, the trochanter being 1 to 2½ cm. above Nelaton's line. In two patients, however, no shortening was recorded.

4. Movements at the joint. In the large majority restricted motion was noted. Neither flexion, adduction, abduction, or rotation is normal. The limitation in the arc of rotation of the neck of the femur is striking.

5. Presence of the femoral head in the pelvis. Probably in every case the head can be felt in the pelvis by palpation through the rectum or vagina. This fact is recorded in fourteen of the twenty-six cases reported.

*Differential diagnosis.* The diagnosis can be made from impacted fracture of the neck and from all other injuries which it resembles except certain other fractures of the pelvis, by feeling through the rectum, or seeing, by means of the X-ray, the head of the bone projecting into the pelvis. From certain other fractures of the pelvis with projection of the head into the pelvic cavity, the diagnosis can be made only by means of the X-ray or by exposure by operation.

*Complications.* Injury to the pelvic viscera, rectum, small intestine, bladder, large blood vessels, and nerves have been produced by the head of the femur or by fragments of bone from the pelvis.

*Prognosis.* Of the twenty-six clear cases there were eight deaths and eighteen recoveries, a mortality of 30 per cent. As to functional results, in only three of the eighteen that recovered could the result be called perfect. In most there was limitation of motion, shortening of 1 to 3½ cm., and so forth; thus, limited motion in seven, shortening in seven, stiffness of joint in two, outward rotation in one, outward rotation and abduction in one, totally incapacitated (at end of three months), one. The number of cases in which shortening remained suggests the opinion that the dislocation was not reduced in these cases, or that it did not remain reduced.

Of the thirty-seven uncertain cases in which the result was given there were seventeen deaths and twenty recoveries; mortality 47 per cent.

*Treatment.* Reduction should be attempted as advised by the usual methods; namely: by traction outward and downward in the axis of the neck of the femur. Strong adduction and abduction, with the thigh flexed at right angles on the pelvis, have been tried, but great care should be used lest the fracture be made worse, the femoral neck itself be broken, or the pelvic viscera lacerated. Failing in these, the dislocation should be reduced by open operation.

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# TREATMENT OF UNUNITED FRACTURE[1]

By EDWARD MARTIN, M. D., PHILADELPHIA
John Rhea Barton Professor of Surgery, University of Pennsylvania

IT is commonly accepted to-day that, given a clean surgeon and a proper armamentarium, all accessible fractures in which the broken bone ends cannot be placed and retained in such position as to insure reasonable function and the absence of gross deformity should be promptly subjected to open operation; that all fractures of the long bones in which, after apparent satisfactory reduction, crepitus cannot be obtained should be examined through an incision and secured in position after removal of interposing soft parts; that compound fractures should as a rule be opened, cleansed and neatly apposed with some retentive appliance, and, finally, that ununited or viciously united fractures of long standing should be subject to operative treatment without previous trial of conservative methods.

The disadvantages of the open treatment of fracture are that it is at times attended by pronounced shock and bleeding; that the utmost care may fail to insure against immediate or remote infection, that union is generally delayed, at times failing entirely.

Hæmorrhage can nearly always be prevented by the use of a constricting band, and this is indicated except when the seat of fracture can be readily reached and the reduction and fixation easily and rapidly accomplished; conditions which obtain in the great majority of recent fractures. Shock, if pronounced at the time of injury, is a distinct temporary contra-indication for operation, and by its persistence, without what would be considered in a normal individual an adequate cause, may become a permanent one. Thus there was brought to the University Hospital a boy with a nearly transverse compound fracture of the mid-portion of the femoral shaft, so profoundly shocked that for days there seemed little hope for his life, for weeks not much more than a hope. A skin and subcutaneous infection, becoming recurrently acute and widespread, delayed his convalescence and added to the difficulty of retaining his bone ends in proper relation to each other. By the time his general condition was satisfactory his bone had united firmly, with overlapping of 2½ inches, and with excellent function, the shortening being readily corrected by a high shoe. Operation was not advised, on the ground that the patient had exhibited a peculiar susceptibility to both shock and infection. The traction needful to overcome shortening is in itself a shocking procedure and in this case would probably have to be discontinued before a satisfactory degree of lengthening could be obtained.

It is particularly in the open treatment of delayed union with marked deformity, of vicious union, or of non-union of the femur, that the ability of the patient to withstand shock must be most carefully considered, since, unless the surgeon be content to resect and secure apposition with shortening, there may develop a rapid and fatal fall of blood pressure incident to traction alone. In one instance of non-union following a compound infected fracture, with nearly three inches of shortening, the bone ends were readily freed with very little bleeding, the traction band was applied to the proximal end of the distal fragment and in a few minutes with a pull of a hundred and twenty-five pounds the shortening was reduced two inches. There then developed rapidly a progressive fall of blood pressure with pulse acceleration which made needful a prompt discontinuance of traction. An inch and a half of bone was resected and the sawn bone ends were placed in proper relation one with the other. In one other case careful observation of pulse and blood pressure gave timely warning as to when traction had been carried to its safe limit. One case, in which direct traction on the bone ends was not used, this being a fracture of both femora, died of shock.

As to infection, if scrupulous cleanliness be observed, the probability of its immediate

[1] Read before the American Surgical Association, Montreal, May, 1912.

or remote manifestation is proportionate to the size and in a measure to the nature of the foreign body introduced for retaining purposes, and to the extent of the local trauma inflicted at the time of operation. Moreover, even though immediate infection be avoided, it may develop weeks, months or years afterward, though this late infection is usually of slight moment and is rapidly cured by removal of the buried splint.

Immediate infection implies a more or less extensive osteomyelitis with necrosis, widespread purulent infiltration of the soft parts and a profound systemic intoxication directly threatening to life. Early free drainage and the removal of the buried splint are immediate surgical indications. Even with every precaution taken, after a difficult fracture case, the surgeon can scarcely feel the same assurance of cleanly healing as he does, for instance, after a total excision of the breast.

Mainly because it lessens trauma and shortens the time of operation a proper armamentarium is one of the most potent factors in guarding against wound infection. Moreover, both the extent of the trauma and the bulk of the buried splint have an influence on delayed union. Thus the same predisposing factors favor both infection and slow or imperfect repair.

In general, it is true that children rarely require open operation for fracture of the long bones, first, because in them reduction is usually accomplished without difficulty, or even should it fail, not only does union take place, but deformity undergoes a modelling process and tends to disappear. Thus a child who had been casually treated for femoral fracture, presented himself with a bowing of the femur so obvious as to be seen through his clothing at a distance. His parents refused operative correction, which, for that matter, was not urged. A year later, without any treatment, this bowing was so nearly corrected as to be detected only on careful examination. In the adult there is a tendency in the opposite direction.

Failure to recognize the importance of obtaining crepitus when fractures of the long bones are apparently perfectly reduced is responsible for a fair number of ununited fractures. If on exposure of a recent break muscular or fascial interposition be found, the removal of this will insure union and, providing the broken ends can be kept in place by splinting, such union will be more rapid if no buried splints are employed. In our experimental work this seemed clearly demonstrated, even intramedullary bone splints seeming to delay or inhibit osteogenesis in the region where it was most needed. Where they are indicated those having the least bulk compatible with securing the desired end should be employed.

The tendency of the day is towards the use of steel plates in all fractures which call for the open operation.

By some surgeons they are employed even for such breaks as those of the olecranon or patella. The plate of choice is that of vanadium steel as designed by Sherman. His tap screws have heads especially adapted to his screwdriver, making their fixation simple and firm, the single disadvantage being that the starting of the Sherman fluted screw is at times difficult. Dr. Eliason has found that a No. 31 drill makes the start easy, that shorter screws can be used without sacrificing the holding power as there is no point; that the screws once started drive more easily and hence lessen the danger of splitting the bone or twisting the screw, that being made of G vanadium the screws are much stronger than those customarily used. He has further shown in his experimental work that G vanadium stands repeated bending, that for the femur the thickness of the plate should be at least $\frac{5}{64}$ of an inch, that the $\frac{3}{64}$ inch plates supplied by the instrument makers are practically useless.

The value of thick plates is incident not only to the fact that they are the only internal splints upon which any dependence can be placed in treating fractures of the femoral shaft under such circumstances as make the avoidance of angling or twisting strains impossible, as, for instance, in fat or largely muscled patients, but that because of their strength they can be made thin and light for application to bone in which the strain of movement uncontrollable by external fixation

apparatus does not occur. This lessened bulk gives an added assurance against either an immediate or remote infection. There is a too broadly accepted belief to the effect that if a fracture be exposed, neatly apposed, plated, properly splinted and the wound remains clean, the union of that fracture is assured. This is not the case. As a rule the presence of a plate in place of stimulating osteogenesis between the broken bone ends retards it. This retardation is in some places so great as to entirely prevent union, I have one case, a fracture of the radius and ulna of the middle third, accurately plated now more than a year ago, remaining clean and showing no union, nor is this case unique. It is also true that a fracture accurately reduced and carefully splinted in the absence of operative intervention occasionally fails to unite, there being apparently not the faintest effort at repair.

The long standing, ununited fracture and vicious union are those which are most difficult and in the case of the femur dangerous. Since the operation may be prolonged and the bleeding free and difficult to check, the Esmarch constricting tube should be used. The effort to restore the leg to as nearly as possible its original length, even when traction is applied to the proximal end of the distal fragment, may be attended by profound and rapidly developing shock. The operative conditions favor infection.

The percentage of failures to unite after a clean operation is probably larger than would be suspected from a study of reported cases, and this failure is probably due to a failure to resect beyond the sclerosed area to a point where the bone marrow is seen. It is generally supposed that plating of these fractures is the best procedure, but this is the case only when apposition and retention are not obtainable by absorbable material or one of less bulk, or by external splinting alone. A case in point, which would seem to show the superiority of plating, and in which there was a successful result probably due to free resection of the bone ends, is that of a girl suffering from fracture of the upper third of the humerus who had shown delayed union of a previous fracture of the clavicle. According to measurements and inspection the replacement was accurate and the after treatment and bandaging was most carefully and skilfully conducted. There was no union and her doctor stated that he had never been able to elicit crepitus. The seat of fracture was exposed, a fibrous expansion from the triceps was removed from between the fragments, the bone ends were curetted and placed in accurate apposition with each other by a silver wire. Again there was no union and a serum injection was given. Finally the bone was resected at the seat of non-union, the marrow of either end being freely exposed and apposition was secured by a plate. Union was delayed but was complete, the arm regaining entire function. It is interesting to note that the wire had held the bone ends in perfect apposition. In such case, and indeed for all cases in which union has failed in spite of proper apposition, it would seem that Murphy's transplanted bone splint would be peculiarly applicable.

Of major moment after the reduction of a fracture, whether it be treated by the open method or conservatively, is the subject of retention. Nor does the application of a bone plate lessen the need for attention to this subject. We at one time hoped to devise an internal splint which might do away with all external support and even allow of a moderate degree of function. The experimental work of Dr. Sweet showed conclusively that recurring slight strain would loosen any appliance which depended for its holding power upon the living tissues of the body.

If satisfactory reduction and retention can be secured without operation, even the most enthusiastic plater would probably recommend this simpler method. Hence it is germane to the subject to refer to the conservative treatment of those fractures of the upper extremity of the femur; and particularly those of the neck of this bone, occurring in old people, and attended under any form of treatment by a large mortality. Death occurs in days or weeks, and is preceded by anorexia, dry glazed, brown tongue, gastro-intestinal breakdown, torpor, muttering delirium or other form of mental failure and fecal and vesical incontinence.

When such symptoms, or the progressive mental and physical asthenia which precedes them, develop, the recognized treatment is to get the patient out of bed, leaving the fracture much to itself. Twice we have had fracture of the base of the femoral neck in feeble old people who gave every evidence of being shortly about to die, in part at least because of the wearing pain incident to movement. The administration of ether with fixation of the thigh in flexion, abduction and slight upward rotation, accomplished by a plaster investment was followed by an immediate relief of pain, control of the sphincters, restoration of mentality and appetite, and ultimately by a functional and apparently an anatomical cure. The immediate beneficial effect was due to local rest.

A rigid adherence to Buck's extension in the straight position is undoubtedly responsible for many unsatisfactory results in femoral fractures.

Practically all fractures of the femur above the middle should be reduced under ether and held in flexion and abduction.

Fixation is best secured by a plaster casing and to make this easy of application the sling exhibited has been devised. Even the grossly fat can readily be handled in it.

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# SURGERY OF THE ARTERIES[1]

## Some Personal Experiences

By ALBERT VANDER VEER, M. D., Albany, New York

*Suppurating wounds complicated with arterial hæmorrhage;*
*Treatment of popliteal aneurysm by pressure;*
*Ligation of the brachial artery for traumatic aneurysm;*
*Ligation of the common carotid for traumatic aneurysm in a girl two years old;*
*Ligation of femoral artery—immediate hæmorrhage—digital pressure for two weeks;*
*Ligation of external carotid—section removed with tumor;*
*Ligation of common carotid previous to removal of tumor involving the parotid gland and tonsil;*
*Ligation of left subclavian for aneurysm of middle third;*
*Two cases of arterio-venous aneurysms—traumatic;*
*Ligation of common carotid in two cases of congenital arterio-venous aneurysm;*
*Direct venous transfusion in a case of severe postpartum hæmorrhage.*

IN his famous autobiography Dr. Samuel D. Gross speaks of immediate and secondary hæmorrhage in a very fascinating manner. Those of us who look back upon experiences associated with the keen responsibilities pertaining to an active operative practice can appreciate his feelings very clearly when he describes the ringing of the night bell and the dramatic manner in which the message is delivered. The case operated upon that day, or a few days previously, is reported having a serious hæmorrhage, and the surgeon must return very promptly to the bedside of the patient to note that such is the case, for the condition is one of keen anxiety. The operation that had been done with so much care and skill is to go for naught, and now the saving of the patient's life is the important consideration. What to do, and to do it speedily requires brave, efficient action. What a chapter could be written on these messages—first delivered in the above manner, later in the form of a telegram, then the speaking tube, now the telephone, and the agony and distress in the mind of the operating surgeon as he listens to the unpleasant news.

In the life of the surgeon nearing the end of his fifth decade of practice, whose introduction to this kind of surgical anxiety was by way of the battlefield, he can only exclaim

[1] Read before the American Surgical Association, Montreal, May, 1912.

Fig. 1.

how wonderful has been the progress in this part of our work, and why? The surgeon of to-day, in his knowledge of gross anatomy, is perhaps no better informed, nor, as an operator, more skilful than in the days of Dr. Gross. Must we not admit that to the careful observation and study made by the many surgeons who developed during and after our Civil War, to the great work of Lister, to the original investigations in pathology, evolved by the discovery of pathological microörganisms, and operative technique, is due the great advances made in the surgical side of our profession? The application of all of this careful investigation has been of much value in treating lesions of the circulatory system. I wonder how many of those who are within the range of my voice can recall cases of hæmorrhage associated with suppurating wounds? I fancy very few, yet in the early half of my practice these were the fearful experiences we had to encounter in the treatment of such conditions. No emergency work seemed so serious.

The writer recalls a suppurating wound, as shown in Fig. 1, of gunshot injury to the scalp. This was in the case of a young man who, after being wounded met with great exposure during a severe rain, then exceeding heat, when all wounds suppurated to a great extent, but this one especially. Hæmorrhage from the temporal artery occurred, which persisted for the first few days, then being controlled by ligation. Hæmorrhage again at the end of the eighth or ninth day, and finally ligation of the common carotid.

Another case was of phlegmon, or cellulitis of the palm of the hand, where secondary hæmorrhage persisted, and finally ligation of both the ulnar and radial arteries was resorted to with recovery. It used to be a very interesting study in these cases of ligation of important arterial trunks to note the change in the condition of the wound itself. Suppuration was lessened at once, the area of sloughing ceased, and unless death, in the form of gangrene in connection with the arm or leg presented, it was very seldom the wound did not improve, except in cases of advanced age, with arterio-sclerosis, or, as we called it at that time, calcification of the arteries; yet hæmorrhage at the point of ligation very seldom occurred, and wounds would be greatly benefitted and go on to improvement.

I love to review my personal experiences in regard to treatment of the various aneurysms, and can only illustrate, by a single case treated in 1870, a popliteal aneurysm in a man aged forty years, who had suffered from specific disease and developed a well-marked tumor in the left popliteal space. Various methods were suggested by several consulting surgeons and an attempt was made to use a tourniquet over the femoral artery in Scarpa's space, but this was not successful. The suggestion of ligating the femoral artery was not favorably considered by the patient. The leg was finally flexed upon the thigh, and keeping the patient well under the influence of opiates, watching the foot with care, pressure was increased and an ultimate cure brought about, good use of the leg following, after some six months of marked muscular weakness. He then resumed his occupation as engineer in charge of a locomotive on the New York Central Railroad for a period of nearly five years. At the end of this time, when, as he was stepping from

the ground up to the first step of his engine, he was seen to fall backward and immediately expired. An autopsy was allowed and revealed a rupture of an aneurysm of the thoracic aorta.

Think of this treatment, and that of all aneurysms, traumatic or idiopathic, and consider the brilliant advances that have been made since in the entire removal of the sac, and of the end-to-end anastomosis of great arterial trunks.

The treatment of traumatic aneurysm along at this time, about 1871, did not call for any great discussion regarding the method of operating.

The case of Mr. A. B., aged sixteen years, who had met with an accident in which the brachial artery was punctured by a pen knife. Immediate hæmorrhage was quite severe and distinctly arterial. Compresses and bandage applied and wound healed kindly. In about six months an aneurysm, nearly the size of an English walnut developed — beautiful in every respect, and with all the characteristic symptoms. The vessel was exposed above the tumor, ligated with silk sutures, which came away about the fourteenth day, and nothing more was done. The wound healed kindly, collateral circulation was all that could be desired, and patient made a good recovery. He was seen for years after and no further trouble presented. The sac apparently disappeared through nature's processes.

Such cases, after the establishment of aseptic surgery, were treated with less anxiety, particularly when the absorbable ligatures were introduced, as the following case will illustrate:

M. F., age two years, family history good. Child was born with spina bifida in cervical region. At the age of six months I removed the sac and patient made a good recovery. When two years of age, May 15, 1906, she swallowed an open safety pin. Patient had a severe choking spell, was given emetics and vomited, but relief did not follow. It was thought the pin had lodged in the pharynx or upper portion of the œsophagus and could not be reached. Constant irritation was present, and at the end of the ninth day the pin was vomited. Six days after swallowing the pin she had a hæmorrhage per mouth of about a teaspoonful of blood in the morning, and one at five o'clock in the afternoon, similar in character. The following noon had another like hæmorrhage, supposed to be caused by swallowing a piece of bread. The following morning at three o'clock had a severe hæmorrhage, parents said in amount nearly a quart of blood, and child thought dying. No pulse could be felt. Several physicians were in attendance, but no attempt at operative intervention made. On this day there were several slight hæmorrhages, although not as severe as the first of the kind. Forty-eight hours after swallowing the pin an enlargement was noticed in right side of neck, anteriorly. Until the pin was vomited this tumor enlarged to one-half the size it eventually attained, then grew slowly to present size, September 18, 1906. Pulsation in the tumor had been noticed for past three weeks very distinctly. On pressure over the common carotid the tumor would entirely disappear, and diagnosis of traumatic aneurysm was made. Operation done. Exposure of the common carotid, ligation of the vessel, also of the distal end above the tumor, and sac dissected out. Small drainage tube introduced and antiseptic dressings applied. Patient made an uninterrupted recovery and has remained well since. Undoubtedly the open end of the pin, while it remained, was lacerating the artery.

In the ligation of arteries, associated with arterio-sclerosis, or, as we classified them years ago, atheromatous or calcareous, how greatly has our anxiety lessened since we have learned to understand blood pressure and surgical technique. Let me illustrate:

Mr. A. B., age 62 years, October, 1879, presented with gangrene of the foot, due to arterial change. Amputation of thigh, middle third, silk ligatures cut short, and wound closed with drainage tube. On the tenth day, a very severe hæmorrhage occurred. His pastor, a man of great intelligence, was visiting him at the time, and succeeded in controlling the hæmorrhage by pressure of the artery above. On studying the case carefully, and realizing the wretched condition the femoral artery was in at the time of the amputation, I suggested to my medical students that digital pressure would be a safe procedure in order to save his life. Three of them at once volunteered to perform this duty and kept it up for a period of nearly three weeks. The patient made a good recovery and lived for a number of years afterwards, finally dying of cerebral hæmorrhage.

The intelligence and heroism of these students was an indication of their later success as practitioners, one of them becoming a very prominent professor of surgery in one of our Western colleges, and the other two are successful general practitioners in this state.

In ligating arteries in an advanced stage of arterio-sclerosis, I am satisfied that it is wise to pass the ligature around as much of the fascia, in the immediate neighborhood of the vessel, as is possible, in this way forming a sort of cushion in which it may rest, the pressure of the ligature being sufficient to arrest

the hæmorrhage and not injure the coats of the vessel any more than can be avoided. Then, with good elevation of the stump, there is less likelihood of secondary hæmorrhage following.

I have been greatly interested in operations about the neck, pharynx, the spheno-maxillary fossa and ligation of the carotid arteries. I cannot say just how often I have ligated these vessels, but am greatly impressed with the necessity that frequently presented, in serious cases, of taking these preliminary steps when extensive dissections are to be made.

In May, 1876, Mrs. A. B., age about 35 years, developed a growth in right side of the neck, along the angle of the jaw, which gradually grew upwards. Patient treated at various times for enlarged glands, but growth continued to enlarge for a period of eighteen months. When she presented, the tumor was movable and an operation advised. In doing this I was obliged to ligate the proximal, also the distal end of the external carotid, using silk ligatures. The tumor proved to be a fibroma, and passing nearly through its longitudinal center was the external carotid. This patient experienced some little dizziness and occasional loss of consciousness for ten days after the operation, then made a good recovery. I have had an opportunity of seeing her for a number of years, and she had has no unpleasant symptoms nor return of the disease.

Tumors within the pharynx, and especially of the tonsils, have attracted my attention, and I very earnestly endorse ligation of the common carotid, if operation is called for, for the ease with which a thorough dissection can be made is very gratifying.

Mr. McE. J., age fifty-one years, a prominent citizen, in business, and holding other important positions of trust, presented November 19, 1906. Good family history, aside from an early tendency to arterial changes. Mother died of heart trouble, one sister of angina pectoris, and two brothers, one of myocarditis, the other of arterio-sclerosis. Patient had typhoid fever several years ago, varioloid when a boy, pneumonia eighteen years ago, and passed renal calculus some few years since. Uses stimulants and tobacco somewhat moderately. Has had a number of attacks of tonsilitis. May, 1906, noticed an enlargement, nearly the size of a hickory nut, in right side of neck. This remained stationary for about three months, at the end of which time it began to grow, and is now slightly larger than when it first made its appearance. Is movable and presents a large growth inside of the pharynx, and involving the tonsil, which is movable on pressure from within. Tumor involving tonsil believed to be sarcoma.

Examination of the urine showed a normal condition of the kidneys. Examination of blood: Red blood cells 4,800,000; leucocytes 10,600; hemaglobin 90 per cent.

Operation decided upon as the only treatment, and performed at the Albany Hospital, November 20, 1906. Incision for ligation of common carotid was done as a preliminary step. Next an incision extending from the inferior angle of the ear down along the sterno-cleido mastoid muscle was made near to the incision for ligating the artery. This gave us a very thorough exposure of every part of the field of operation, and would have permitted section of the lower jaw had it been necessary.

Section was made of external jugular vein, and it was noted it became necessary to tie the lingual and palatine arteries. Tumor was dissected out very carefully, which involved taking out a portion of the soft palate and uvula. In the course of dissection the anterior belly of the digastric muscle was severed. During the operation any traction of the mass gave severe dyspnea, and at this point the chloroform and oxygen apparatus was substituted for the ether, and the cyanosis and coughing was relieved.

Much of the dissection about the soft palate was done with serrated scissors. Some portions of the deeper parts of the wound of the pillars of the fauces were brought together with silk and catgut sutures, and elsewhere in the lateral portion of the tongue. External wound was closed with continuous chromocised catgut sutures. Pencil-sized rubber drainage tube was necessary at the lower angle and the usual dry dressing of vioform gauze applied. There was considerable drainage for a period of four or five days. Patient made a nice recovery from the anæsthetic, and progressed very favorably, leaving the hospital December 10, 1906.

I saw the patient a few days since and he is in excellent health.

The following report from the Bender Hygienic Laboratory is presented:

The specimen which you sent to the laboratory some time ago, from the tonsil and cervical lymph node of Mr. McE. J., has given me considerable thought and some concern. At the time of the operation a frozen section was made, and the condition was called a spindle cell sarcoma. The portion examined was certainly of this character. A large number of celloidin sections have been cut out since and while some show in places a very typical picture of spindle cell sarcoma, others are suggestive of a peculiar type of carcinoma, while in other places there is a picture which is usually seen in the mixed tumors of the parotid gland.

Is there any possibility that this tumor might have arisen in the parotid?

I cannot thoroughly believe that we have a combination of two types of tumor occurring in the

original growth of tonsil and in the metastasis of the lymph node. I have therefore sent sections to Dr. F. B. Mallory, Harvard Medical School, in order to procure another opinion. Until I receive such I do not care to make a final diagnosis. I trust this will be satisfactory to you.

Sincerely yours,

R. M. PIERCE.

Director, Bender Hygienic Laboratory.

Dr. Mallory reports, Dec. 21, 1906, that "the concensus of opinion regarding the specimen sent is that it is a carcinoma, primary in the tonsil, with metastasis in the cervical lymph node."

At the present time there are few surgical operations that call for more perfect surgical technique than the ligation of arteries.

The following case is of interest: Mr. T. M., age sixty years, a prominent publisher, was admitted to the Albany Hospital June 24, 1908, with a history somewhat as follows:

Over three months ago noticed pain starting just above the elbow and extending down to middle fingers; dull in character and aggravated by trying to lift anything. Careful physical examination developed the fact that the pulse was less regular in left radial than in right. Pain was not relieved by treatment and another examination made two weeks after the first, when tumor was discovered just above the clavicle, and tentative diagnosis of aneurysm of subclavian artery made. Bruit was very distinct, and when pressure was made close up behind the upper portion of the sternum it stopped the pulse in wrist and there was diminution of the enlargement. Patient had been on iodide of potassium for some time, but without any apparent beneficial effect. The tumor now presented about the size of the end of thumb, and pulsating synchroniously with heart beat.

Incision made along the anterior portion of clavicle, three inches in length, tissues retracted backwards and by careful dissection, the artery, together with a portion of the brachial plexus, was exposed, when an aneurysm in the second portion of the subclavian was brought to view, fusiform in character, and having its narrowest part at the inner portion of the clavicle. Two cumol catgut sutures, No. 3, were passed around the artery, one at the proximal and the other at the distal portion of the aneurysm, and tied, at the same time the artery being controlled at the wrist. It was noted that the tying of these ligatures absolutely shut off the pulsation, although the next day, and for a few days afterward, his family physician, Dr. Ward, thought he could get a faint pulse in the radial. The inner tubercle of the first rib was found lying just beneath the aneurysm and pushing it upward and outward, making it very prominent. No malignancy whatever was found, and there was no traumatism of the brachial plexus during the course of the operation. Wound then closed with cumol catgut, and one small cigarette drainage tube inserted in outer angle, with usual vioform dressing applied. Arm was wrapped in cotton, held in position with bandage, the fingers being left exposed.

Patient made a good recovery, leaving the hospital July, 1908. No unusual complications presented; there was immediate improvement and good ultimate recovery. He has been examined several times since, and quite recently, and no pulsation can be detected in the left radial artery.

One pauses to express our appreciation, in all the work connected with the arterial system, to Matas for his tests regarding the collateral circulation. This is also true of the experimental work done by Carrel in his end-to-end suture method, and, more recently, the experimental work done by Horsley, of Richmond, in suturing blood vessels, also by Boothby and Ehrenfried, of Boston, in their experimental work upon pregnant cats.

Arterio-venous aneurysm, congenital or traumatic, has always interested me a good deal. They are certainly, in some instances, a most formidable surgical lesion with which to come in contact.

Among my first cases was that of Mr. S., a son of the original proprietor of Spalding's circus, a vigorous looking man thirty-two years of age, who had been shot, the pistol being of thirty-two calibre. The man who fired it stood somewhat above, firing downward, and the bullet passed in just above Poupart's ligament, lodging downwards near the spine of the ischium, as nearly as we could discover. He bled quite profusely at the time and the wound was thought fatal, but the point of entrance of the bullet healed and I saw him about ten days after the accident. There was a fairly good pulse in the femoral artery, in the upper portion of Scarpa's space, but within the pelvis a distinct pulsation could be observed. The physician who had dressed the wound stated he was able to observe positively the condition in the flow of blood, the dark venous and bright arterial being quite impressive, and upon this statement the diagnosis was later made of traumatic arterio-venous aneurysm. At that time our fear of entering the peritoneal cavity, particularly in the male, and doing so serious an operation as ligation of the external or common iliac artery and veins, deterred me from going on with the operation, which, at the present time, we would not hesitate to do. The tumor increased quite rapidly, showing clearly a case of arterio-venous aneurysm, the patient dying of hæmorrhage within two months.

I have since seen some few somewhat similar cases, but more particularly the following:

Mr. P. J., age seventeen years, on the morning of July 4, 1880, was seen by his family physician, Dr. Cook, the history being that while Mr. J. was walking in the yard he heard the report of a pistol and soon realized he had been shot in the right leg. Our examination, soon after receipt of the injury, indicated that the ball had entered the popliteal space. At first the hæmorrhage was quite serious, and a hæmatoma formed in the popliteal region. A slight pulse could be felt in posterior tibial, and no effort was made to locate the bullet. The foot was elevated, clean, aseptic dressings applied, and the patient kept absolutely quiet. The question of enlarging the opening, rolling out the clots, and finding the injured vessel was considered at the time, but the family were not inclined to have this done. The patient made a very good recovery, and no untoward symptoms presented until about six months after the injury, when the indication of an arterio-venous aneurysm was quite decided. The parents still disliked the thought of operative intervention and the case was postponed. Soon after this they moved from the city and patient was not brought under observation again until February, 1901.

The leg was now ulcerated at different points the aneurysmal sac was very large, could be felt part way up the thigh, and his condition was becoming one of great anxiety owing to two or three serious hæmorrhages he had had. We thought at first that by opening the popliteal space we might yet be able to do some good conservative work, but the hæmorrhage was so great at the time of the operation, February 21, 1901, that amputation through the thigh became absolutely necessary. In a similar case at the present time, with our knowledge of the repair of arteries, we would have undoubtedly persuaded the parents to have the operation done the day of receipt of the wound, and probably with success. At the time of the amputation, the ball was found in the popliteal space, resting between the condyles of the femur, encysted, and not in the aneurysmal sac. The patient made a good recovery and has remained well since, using an artificial leg quite successfully.

Regarding cases of congenital arterio-venous aneurysm I have had excellent results following the use of the thermo-cautery, passing the fine point quite near the edge of the healthy skin. I have thus seen atrophy take place, and complete recovery follow in quite large masses. Some of these very serious and appalling cases which present at times, in which the eye is closed, in which it is evident that the spheno-maxillary fossa, and in one case the upper right portion of the mouth is invaded, may be illustrated by the following report:

The patient, baby M., age fourteen months, was born with a moderate sized arterio-venous growth just under the right eye. It was treated with local applications with great persistency, yet the tumor constantly enlarged. When I saw the child at the end of the fourteenth month it swallowed with difficulty, and the mouth was filled with a mass, making one think it might be a case of sarcoma, but evidently of the nature of an arterio-venous aneurysm. The parents were very disconsolate, and I was urged, if possible, to do something for its relief. Pressure upon the common carotid reduced the growth very decidedly, and it was thought wise to ligate the artery, to which the parents readily consented. This was done and within an hour after the growth had subsided nearly one-half. The patient recovered from the ether and at the end of twenty hours we had strong hopes that the little one was improving, but she died very suddenly thirty hours after the operation.

Within a year after, my son, Dr. Edgar A., encountered a case almost precisely similar. Ligation of the artery was done as a preliminary step, and about three weeks after a second operation was done for dissecting out the enlarged vessels, which produced an unsightly tumor of the cheek, the patient making a fine recovery.

One realizes that operations like the last two are very much more formidable and that there seems to be little excuse for allowing cases to go on suffering in this way when an early and less serious operation can be done so successfully.

In connection with malignant tumors of the mouth, and especially the tongue, I am very much in favor of ligating the arterial supply, for instance the lingual artery. I have seen patients made much more comfortable, and retardation of the growth result, when ligation has been employed.

I have been greatly impressed with the few cases of aneurysm of the extremities met with during the past twenty-five years. Beyond a doubt syphilis has been treated with greater success during this period, and fewer circulatory lesions resulted, or, possibly, as a people, we are becoming more immune.

While at the present time we may have cases of immediate hæmorrhage, as the result of some break in our technique, such as poor catgut, or possibly a diseased condition of the arteries, yet it is seldom met with, and is another tribute to our advanced aseptic

surgery. I take it very few of us meet with secondary hæmorrhage.

In studying the papers that have been presented in such an able manner by Drs. Crile, Matas, Carrel and others, I am led to make some observations regarding our efforts to save patients, in the beginning of my practice, by the direct intravenous injection of milk or transfusion of blood by the many appliances spoken of at that time, or by the direct transfusion from person to person.

During the past winter it was my privilege to meet a patient upon whom I did a direct transfusion, some thirty-five years ago, after she had suffered from a very severe hæmorrhage following the birth of her first child. Anæmic convulsions were present and patient pulseless. Her brother, a physician, permitted exposure of his median basilic vein, and connection with the same in her arm was made by means of the Aveling apparatus, which was done with considerable embarrassment, it being difficult to get at her collapsed vessel. Although we were working with little knowledge of our present aseptic preparations, and methods of sterilization, no sepsis followed. Just how much blood was transfused we were not able to tell accurately. The donor felt the effect somewhat and it was very evident after fifteen minutes that the patient herself was being benefitted. Pulse could be felt, the instrument was removed, compresses applied, and patient made a good recovery. This was my earliest attempt at direct transfusion. Just here I wish to place on record the great good I have seen resulting from the use of the normal salt solution by hypodermoclysis in cases of shock from severe hæmorrhages.

The method of anastomosis of blood vessels at the present time is looked upon as a comparatively simple procedure; however, it requires the greatest amount of coolness on the part of the attending surgeon. The anxiety of the friends, the responsibility resting with the operator that everything be thoroughly aseptic, and that the technique be absolutely perfect, help to make the nervous tension on the surgeon greater than in many of our major operations.

In doing many of these operations I wish to express my appreciation of the assistance rendered by the late Dr. W. G. Macdonald, my sons, Drs. Edgar A. and James N. Vander Veer, and Dr. J. L. Bendell.

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# A CASE OF NON-TRAUMATIC DIAPHRAGMATIC HERNIA[1]

## Operation; Recovery

By CHARLES L. SCUDDER, M. D., Boston
Surgeon to the Massachusetts General Hospital; Lecturer in Surgery at the Harvard Medical School

By diaphragmatic hernia, I understand the protrusion of a viscus from its natural containing cavity through a normal or abnormal opening in the diaphragm. Diaphragmatic hernia may be congenital or acquired. I understand that a congenital invitation to a hernia may exist and the hernia not form until a variable time after birth. There are about one thousand cases of diaphragmatic hernia recorded. A large proportion of these cases were discovered at autopsy.

There have been about fifty-three operations done for diaphragmatic hernia. The approach to the hernia in the operated cases was through the thorax by thoracotomy in eleven cases; seven recovered and four died.

The approach to the hernia was through the abdominal wall by laparotomy in forty-two cases, seven of which recovered and thirty-five died.

A diagnosis of diaphragmatic hernia was made in only six of these operated cases, once

[1]Read before the American Surgical Association, Montreal, May, 1912.

Fig. 1. Shadow (X-ray) seen in left side of chest previous to operation for cure of diaphragmatic hernia. Lying down.

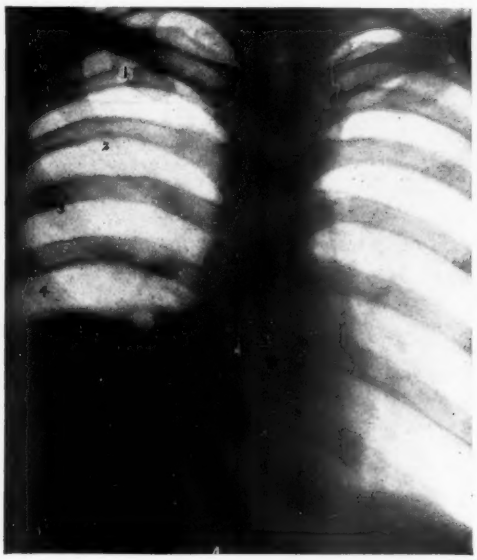


Fig. 2. X-ray same as figure 3, only taken partially. Note height that shadow rises. Before operation. Standing.

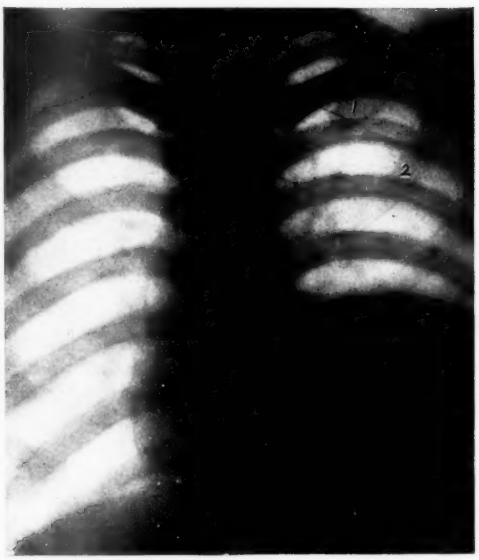


Fig. 3. X-ray. Diaphragmatic hernia. Note the height (before operation) at which stomach enters the left chest. 1, 2, 3, mark the ribs. Anterior view. Standing.

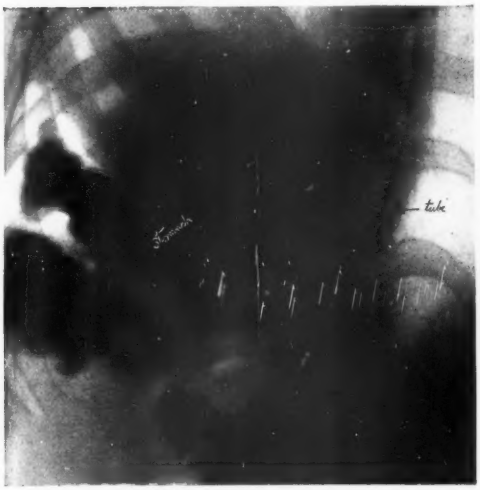

Fig. 4. X-ray. Diaphragmatic hernia. Note the bismuth stomach tube *in situ* and stomach in left chest.

Fig. 5. X-ray of bismuth stomach tube *in situ*. Note the curving of the tube as it passes through the ring of the diaphragmatic hernia. Bismuth shadow seen in left chest is the displaced stomach.

each by Abel,[1] Albanese,[2] Heidenhain,[3] Kayser,[4] Wieting,[5] Giffin-Mayo.[6]

The operation has usually been undertaken for intestinal obstruction, hence the high mortality. One of the recently reported and successfully operated cases is that of Giffin and Mayo from the Rochester, Minnesota, clinic. This was one of the six cases which were diagnosed previous to operation.[6]

Giffin presents a long bibliography covering much of the literature of diaphragmatic hernia. I have discovered one paper not mentioned in this bibliography which is valuable—a paper by an Italian, A. Salomoni, published in La Clinica Chirurgica, Milano, 1910. All cases to that date are analyzed and the details of each case are concisely stated. This article is valuable.

I wish to record the facts concerning one case of non-traumatic diaphragmatic hernia in which the diagnosis was made previous to operation, and in which a stated operation for the repair of the hernia was successfully undertaken.

[1] Berl. klin. Wchnschr., 1895. Died.
[2] Reforma med., 1904. Recovered.
[3] Deut. Ztschr. f. Chir., 1876. Recovered.
[4] Mitt. Hamb. St. Krankenh. Ztschr. f. Chir., 1898. Died.
[5] Deut. Ztschr. f. Chir., 1879. Recovered.
[6] Annals of Surgery, March, 1912, p. 388.

Theodore L., an Italian laborer, 29 years old, was operated upon by another surgeon in December, 1909, for a cholecystitis; a cholecystotomy was done. The record states that at this time the duo-

Fig. 6. Diaphragmatic hernia. Note the line of the curve, lateral abdominal incision *x*–*y*.

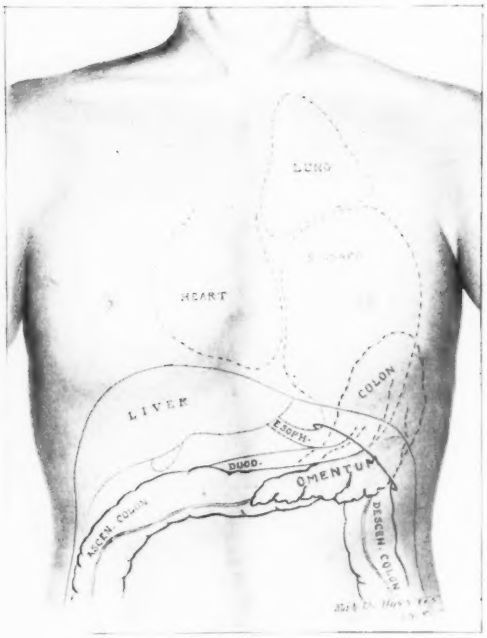


Fig. 7. Diagrammatic drawing showing relative positions of viscera concerned in this case of diaphragmatic hernia.

denum, stomach, and appendix were normal. He was well after this operation until January, 1911. He again entered the Massachusetts General Hospital (March 7, 1911), complaining of epigastric pain, sour eructations, and constipation. He was free from pain when he had eaten nothing. His diet then was milk, soups, and rice. He had lost about twenty-eight pounds from January to March, 1911. He obtained relief from pain by vomiting.

Heart. Apex impulse seen and felt in fourth space, nipple line, 10½ cm. from middle-sternum. No right sided enlargement found, or increase in retrosternal dullness. Action clear, regular, sound of good quality. No murmurs heard. Pulmonic second sound not accentuated, of good quality.

Pulses were equal, regular, synchronous and of good quality.

Lungs. Equal and good expansion, sounds negative. Abdomen, negative. Systolic blood pressure, 120. Blood hemoglobin, 95 per cent. W. C., 12,000. Urine, few brown granular casts, no sugar. Alb., s. p. t. Stool, normal.

Stomach wash. Tube passed, causing much retching. Few cc. clear fluid with few food flakes obtained from fasting stomach. Wash water clear. Capacity not obtained on account of vomiting. Test meal vomited. Then about five and a half ounces of a dark yellow fluid with considerable residue were obtained. On inflation, stomach borders appeared normal.

Examination stomach contents. Fasting: 15 cc. turbid, rather thick contents with slight sediment which shows many starch granules, a few fat globules. Occasional yeast cell. No sarcinæ present. Free hydrochloric acid present. No lactic acid. Ewald test meal 160 cc. Contents, 1/10 sediment of partially digested food, 1/10 scum of thick mucoid material. Free hydrochloric acid, .036 per cent. Total acidity, .108 per cent. Vomitus, 120 cc. of material vomited after the test meal was given. Free hydrochloric acid is present.

While on the medical service, the patient vomited each day rather large amounts (18 to 100 ounces). The stomach was frequently washed clear. Upon a restricted diet, the patient gained a little in weight. When given a real meal (unrestricted), he always vomited.

March 24, 1911, the patient complained for the first time of pain in the left chest. An X-ray taken at this time showed a dense shadow on the left corresponding to an area of tympany over lower left chest. (See Fig. 2). The heart was found moderately pushed over to the right side. The fluoroscope examination showed the movements

Fig. 8. Diagrammatic drawing showing position of diaphragmatic opening. (a) Edge of liver; (b) stomach; (c) diaphragm; (d) spleen. 1–2, enlarging incision of hernial ring.

of the diaphragm on the left side to be practically normal, although the motions of the left chest were slightly restricted. The bismuth X-ray showed that the stomach was dilated upon the left side. It was thought that the patient had a pyloric obstruction from some cause. A diaphragmatic hernia was suspected. An X-ray taken with a bismuth filled stomach tube in situ disclosed the fact of a diaphragmatic hernia. The stomach tube could be seen passing upward into the stomach shadow in the left chest. (See Figs. 4 and 5). The destruction of the definite dome-shape characteristic of the normal diaphragm line is noted in the X-ray. The X-rays were taken by Dr. Walter S. Dodd, skiagrapher to the Massachusetts General Hospital.

March 31, 1911. A laparotomy was done to determine the conditions present. The diagnosis was confirmed; the omentum and transverse colon and stomach were seen to have left the abdominal cavity and to be in the left chest.

It was evidently impossible in the poor condition of the patient to attempt a reduction of the hernia at this time. The constriction of the colon by the edges of the hernial ring in the diaphragm was the evident occasion of the persistent vomiting at daily intervals. Consequently, I was able to release the obstructed colon and to return it to the abdominal cavity. Nothing further was done at this time. The abdomen was closed.

Fig. 10. Diaphragmatic hernia. X-ray of bismuth stomach shadow taken after operation for repair of the hernia. Note level of diaphragm on each side. The picture is of course reversed, the stomach appearing on the right side. Note that the stomach is wholly within the abdominal cavity.

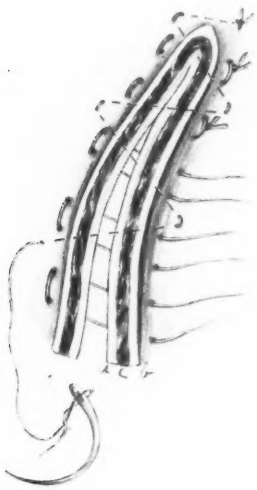

Fig. 9. Diaphragmatic hernia. Note method of taking mattress suture and continuous catgut suture. (a) Pleura; (b) peritoneum; (c) muscle of diaphragm.

The absence of vomiting during the next three weeks allowed the patient to gain sufficient strength so that an attempt could be made to repair the hernia. The patient vomited April 21, 1911, and again April 23, 1911.

On April 25th an operation was done to cure the hernia. Employing his apparatus for positive pressure, intratracheal anæsthesia was maintained by Dr. William C. Quinby, Boston. The under surface of the diaphragm was exposed to satisfactory view by an incision extending from the upper end of the first longitudinal incision, along the left costal margin to

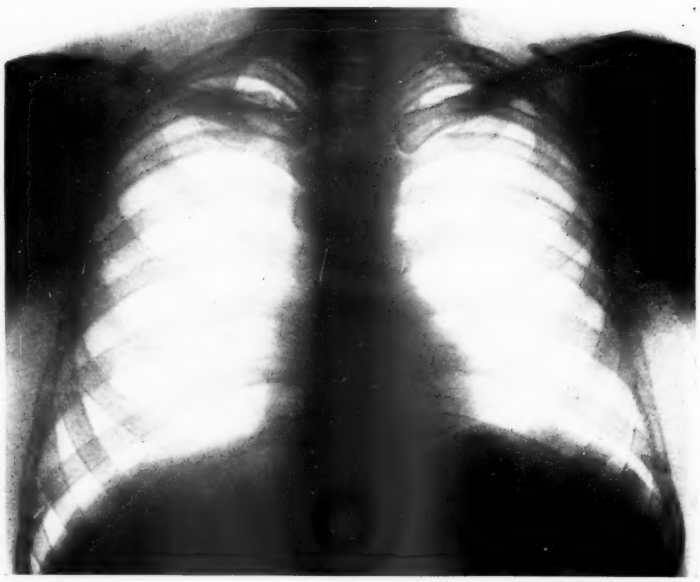

Fig. 11. Diaphragmatic hernia. X-ray *after* operation. Note both chests normal, clear picture. Levels of diaphragm normal.

the loin. (See Fig. 6.) By reflecting this upper flap together with the costal border, an admirable view of the under surface of the diaphragm together with the hernial orifice was obtained. (See Fig. 8.) The abdominal cavity was protected by moist gauze and towels. The colon and great omentum were with some difficulty removed from the chest by traction. There were some omental adhesions posteriorly and anteriorly to the margin of the orifice. (See Fig. 7.)

It was impossible to reduce the stomach by traction. The stomach was full of liquid material. The hernial orifice was enlarged to the edge of the diaphragm so as to admit the hand. A stomach tube was passed into the stomach and with the hand in the chest compressing the full stomach its contents were expressed into a pail on the floor. Traction on the stomach was now more effective in more completely delivering the stomach from the chest. But it could not be entirely delivered. A hand in the chest above the stomach discovered adhesions between the under surface of the lung and the dome of the stomach which yielded to separation. After separating the adhesions the stomach was replaced in the abdomen. By increasing the intratracheal pressure slightly, Dr. Quinby was able to distend the lung so that it expanded, almost filling the chest. While the lung was expanded, a suture of the hernial orifice was placed. An interrupted mattress suture of linen was used. The pleural surface of the diaphragm was everted into the abdomen by the suture. A continuous suture of chromic catgut was taken over the mattress suture. (See Fig. 9.) The lung was seen to be within about three inches of the diaphragm when the last suture was placed. The abdomen was closed.

The patient made a good convalescence. It was possible to demonstrate a slight pleurisy during the first ten days following operation. This gradually disappeared, and with its disappearance the lung occupied the whole left chest cavity naturally. (See Figs. 10 and 11.)

More than a year has elapsed since the operation. The man is well and strong and

working at his old employment of teamster. The drawings and X-rays illustrate several points of interest in this case.

That the man should have been operated upon one year previously and the duodenum and stomach have been reported normal to palpation and sight — and the fact that there had been comparatively few distressing symptoms until just before operation for the hernia, these two facts together suggest that the hernia was of comparatively recent and very gradual formation.

The situation of the hernial orifice on the left side, its position midway between the anterior and the posterior walls of the abdomen, suggest a congenital opening which gradually admitted of stretching. There was no evidence of a hernial sac.

Had it been impossible to reduce the hernia through the abdominal route, I was prepared to do a thoracotomy to assist in the reduction. The abdominal route proved perfectly satisfactory.

The intratracheal anæsthesia employed facilitated the placing of sutures in the comparatively relaxed diaphragm.

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# COMPLETE OBSTRUCTION OF THE DUODENUM RESULTING FROM THE IMPACTION OF A LARGE GALL-STONE[1]

By JAMES E. THOMPSON, F. R. C. S. (Eng.), Galveston, Texas

ON December 14, 1907, I operated on a man sixty-five years of age to relieve a complete pyloric obstruction that had lasted for six days.

*History.* Up to the age of thirty-four, the patient was very slender. He then began to fatten rapidly and afterwards uniformly weighed in the neighborhood of two hundred and fifty pounds. His height is five feet, five inches. He was always a heavy eater, being both gourmand and gourmet. At odd times dizziness made its appearance, and on one occasion he fainted at breakfast and remained unconscious for a few minutes. For many years he treated himself for biliousness, using "blue mass" freely. He never, at any time, suffered from dyspepsia. In fact he declared that his stomach was the strongest part of his body. In 1905, he became very bilious, and complained constantly of pain over the lower ribs in the right axillary line.

In the spring of 1907, after a heavy rich meal, he suffered from a severe attack of acute indigestion, which was associated with vomiting. After this his digestion became very poor and he was forced to diet himself on lamb, milk, eggs and toast. He suffered constantly from pains over the sternum and in the epigastrium. In July he was sent to Mineral Wells and returned in three weeks much benefited, having gained twenty-five pounds in weight. After his return, he steadily lost weight, but suffered from no discomfort except the pain in the right axillary line before mentioned.

About the middle of November he was severely jolted in an insignificant street car accident, but felt no bad after-effects.

On Sunday, December 8th, he ate breakfast as usual. At dinner time he commenced to vomit and continued vomiting at short intervals until the following Saturday when the operation was performed. Apparently neither food nor fluid passed into the duodenum. The vomited matter was great in quantity, much greater in fact than the amount swallowed at any time. At times its appearance was like coffee grounds.

Physical examination revealed nothing of importance. Heart and lungs were normal. Urine was healthy. The patient was still very fat, but the epigastrium was slightly hollow. No particular point of tenderness was discovered. No evidence of tumor was found. There was no distension.

The diagnosis was pyloric obstruction, but no adequate reason could be offered to account for the sudden onset and complete nature.

Operation was performed at the patient's home on December 14th, under ether anæsthesia. The environment, dark day and poor light, and the fact that he had a deep, fatty abdomen, all rendered the task very difficult. A thicket of adhesions was found, entangling the pylorus, duodenum, gall bladder, liver and colon, so dense that it seemed impossible to unravel them. The case looked like one of extensive malignant disease and we had almost decided to perform a gastro-enterostomy and abandon the tumor, when suddenly something slipped from the midst of the adhesions into the stomach which was in the grasp of my hand.

It proved to be a large gall stone, and without further delay a pouch of the stomach containing the stone was clamped to prevent leaking and the stone

[1] Read before the American Surgical Association, Montreal, May, 1912.

removed through an incision which was afterwards closed in the usual manner. Further examination of the site of the adhesions revealed some thickening, but no evidence of the presence of other stones. Apparently the tumor had disappeared. The abdomen was closed without further manipulation.

The after-course of the case was very gratifying. The patient never vomited again. Water and nourishment were retained and passed on without trouble. After a somewhat tedious convalescence, the patient regained his strength and weight, and now weighs as much as he ever did.

All dizziness has disappeared, but the pain in the right lower costal zone in the axillary line still troubles him occasionally. He is now seventy years old and enjoys the best of health, indulging his appetite almost as freely as he did in his youthful days.

The measurements of the stone are as follows: Length, 4.5 cm., width, 2.6 cm., shortest circumference, 8.4 cm.

The mechanism of obstruction can probably be explained in the following way:

For some time, probably for a year, the stone was gradually ulcerating its way from the gall bladder into the duodenum. It evidently passed through the fistula, end on, like a torpedo, and impinged on the opposite duodenal wall. Owing to its great length its nose pressed against the duodenal wall and it was unable to turn either upwards or downwards. The result was mechanical blocking of the duodenum which happened to be complete in this particular case. The manipulation of the adhesions released the stone from its impacted position, and luckily for the patient it was forced upwards through the pylorus.

Obstruction of the duodenum or pyloric orifice by impacted gall-stones is rather a rare accident, if one may judge from the few cases reported.

Much confusion has arisen from indiscriminate handing down of references without verification of their true bearing, and the task of classifying the different causes of obstruction of the duodenum and pylorus concisely and logically has been a tedious one.

I have found it impossible to avoid references to cases of pyloric obstruction and have included them amongst the cases collected. The following remarks therefore will not be confined to duodenal obstruction only, but will also include those of the pyloric orifice.

It appears to me that the following classification, which is founded on a pathological basis, will enable us to present the cases in an orderly manner.

I. Obstruction from within the lumen:
   (*a*) Complete.
   (*b*) Partial.

II. Obstruction from without the lumen:
   (*a*) Complete.
   (*b*) Partial.

### I. OBSTRUCTION FROM WITHIN THE LUMEN

This class contains cases similar to the one forming the basis of my paper.

(*a*) *Complete.* The mechanism is either, first, the impaction of a stone that has escaped from the biliary passages along a fistulous track into the duodenum, but whose size is too large to allow it to pass along the gut; or, second, the mechanical blocking of the lumen of the duodenum by a stone which lies partly in the gall-bladder and fistula and partly in the duodenum

I have been able to collect nine such cases which appear to be well authenticated; and, as they bear directly on the subject matter of this paper, I have added a short abstract of each case in the appendix. In addition to these cases I have also added a short abstract of three others, in two of which (Fiedler and Schuele) evidence exists to lead to the belief that a complete obstruction of the duodenum existed for a few days, but was relieved spontaneously by the stone passing downwards along the intestinal canal. In the third case (Miles) the presumption was that duodenal or pyloric obstruction was caused by gall-stones, and was relieved by the passage of the stones into the stomach, from which they were vomited.

Of the former group (nine cases) one case, reported by Labadie, Lagrave et Madelaine, is exactly like my own. There was a complete obstruction which caused death, and at the autopsy a stone 3 cm. long was found blocking the duodenum. Part of the stone was in the bowel and part in the gall-bladder. In two cases (Pilcher and J. A. Atkinson) stones were found impacted at the duodeno-jejunal junction.

I have found it advisable to reject many cases from this group that were included by other writers, because they have no legitimate right there. The case attributed to Chomel

I have allowed to remain on its historical merits.

(*b*) *Partial.* This sub-class includes an interesting group of cases where the calculus is retained in the duodenum, producing an incomplete obstruction resembling that occurring in stenosis of the pylorus resulting from cancer or scar tissue.

It has been a difficult matter to draw a hard and fast line between cases of partial and those of complete obstruction. Tupper's case appears to have been one of complete impaction of the duodenum with stones. It was not, however, attended with symptoms of complete obstruction. I have thought it wise, therefore, to place it in the class of partial obstructions. Counting Tupper's case, I have collected three cases of this nature. One reported by Gollinger, where a large stone was found in the duodenum lying above a constriction, which existed at the level of a bimucous fistula between the gut and gall-bladder; the other by Graham where a stone in the ampulla of Vater narrowed the lumen of the gut.

I have also included two cases of pyloric obstruction. One by Naunyn where a stone as big as a thumb joint was found at the base of a pyloric ulcer, obstructing the passage; the second by Bouveret, where a large gall-stone lay partly in a fistula between the gall-bladder and the pylorus and partly in the pyloric orifice.

As a contrast to these cases Dufour records an example of a large stone, causing no symptoms of obstruction whatever, which lay in the duodenum of a patient who died of nephritis.

As these cases are relevant to the subject of the paper I have appended short abstracts.

### II. OBSTRUCTION FROM WITHOUT THE LUMEN

Under this heading we include three distinct conditions. First, mechanical pressure of an enlarged gall-bladder on the duodenum or pylorus; secondly, the presence of constricting adhesions, binding gall-bladder and duodenum together and constricting the lumen; and thirdly, some anomalous cases of pyloric obstruction caused by hypertrophic thickening of the muscle, brought on by irritation due to gall-stones and fistulous tracks in the pyloric and duodenal walls. (Hale White and Mader.)

(*a*) *Complete.* Examples of complete obstruction from external pressure are very rare. I have been able to collect one case only where the symptoms of obstruction were complete (Ollendorf). A male aged fifty-eight was taken suddenly ill, and died in forty-eight hours. The patient was insane and was accustomed to swallow large quantities of tobacco. The symptoms were vomiting, diarrhœa, and coma. At the autopsy, two opposed gall-stones 5 cm. long and 2.5 cm. in diameter were found in the gall-bladder. Conglomerate adhesions were present and the pars descendens of the duodenum was compressed and the lumen totally occluded. There seems to have been a possibility that the symptoms were due to nicotine poisoning.

(*b*) *Chronic Obstruction.* Numerous cases are reported which could be placed in this category. In a few cases there is no doubt that the duodenum and pylorus were obstructed mechanically and that the symptoms of vomiting, and so forth, were due to this cause. In the majority, co-incident cholangitis and biliary poisoning were probably the cause of the symptoms immediately preceding death. One cannot help being struck by the similarity in the symptoms presented. A prolonged history of gastric disturbance growing progressively worse until all the symptoms of gastrectasia occurred.

In the great majority, the clinical picture was identical with that of stenosis of the pylorus due to cancer, and in most of the cases subjected to operation a tentative diagnosis of this disease was made. In some cases a tumor was observed in the region of the pylorus, which was afterwards found to be a gall-bladder distended with gall-stones, or a gall-stone resting partly in the gall-bladder and partly in a fistula leading into the duodenum. (Kehr, Pepper.)

Perhaps the most interesting, clinically, are those where the obstruction is due to a true hypertrophic thickening of the pyloric muscle. This seems to have occurred in a number of cases. (Hale White, Mader,

Grundzach, Fleiner, Kehr.) In all except that reported by Kehr, there were fistulous openings between the gall-bladder and pylorus or duodenum, and it is very probable that the irritation of these fistulous tracts was responsible for the hypertrophy of the pyloric muscle and the extreme narrowing of the aperture.

In the appendix I have given references to the most important cases reported in this connection, but the mass of literature is so enormous that only typical cases could be included.

## APPENDIX

### Index to literature and abstract of cases.

#### 1. OBSTRUCTION FROM WITHIN THE LUMEN.

##### (a) Complete

CHOMEL. Hist. Acad. roy. d. sc., 1710, Obs. anat. 3, p. 37.

Courvoisier (casuistisch — statistische. Beiträge zur Pathologie und Chirurgie der Gallenwege) reports that Chomel observed in a woman, aged eighty, twenty-two stones which had collected within a peculiar diverticulum of the duodenum and had given rise to all manner of symptoms.

In including this case it is only fair to mention the often-quoted case of Harley (Tr. Path. Soc., London, 1857, viii, p. 235.) In a dissecting-room subject eighty-seven years old, history unknown, a gall-stone three inches in length was found lying in a cul-de-sac to the right of the duodenum.

BONNET, A. 1828. Traité des maladies du foie.

Man, aged sixty, had been sick for some time. Vomiting became a prominent symptom and was accompanied by obstinate constipation. The symptoms continued without relief until death. At the autopsy a large biliary calculus, one inch and three lines long and one inch and two lines thick, was found engaged in the pyloric orifice, obstructing it completely. The gall-bladder was small and thickened.

TAYLOR. 1884. Impaction of gall-stone in the bowel. Pacific M. & S. J., San Fran., xxvii, pp. 104–105.

The patient, a woman aged sixty-six years. Vague history pointing to cholelithiasis for some time previous to severe attack of obstruction. On December 11, 1883, was seized with violent epigastric pain, nausea, and vomiting. The next day the symptoms were worse, and the vomited matter was stercoraceous. On December 13th, operation was performed. In the lower third of the duodenum a hard mass was found wedged in the bowel. After attempting vainly to break it up by needling, the gut was opened and a gall-stone one and one-half inches long and one inch wide was removed. The bowel was stitched up. The patient died from exhaustion on the fifth day following the operation. The autopsy revealed a bimucous fistula between the gall-bladder and the duodenum.

ATKINSON, J. A. Brit. M. J., Lond., March, 1895, i.

A woman aged sixty-five died from bowel obstruction. At the autopsy a stone one and a half inches long was found impacted in the duodeno-jejunal flexure.

HERZ, H. Deutsche med. Wchnschr., xxii, No. 24, 11 Juni, ss. 379–381, 1896.

Reports the case observed by Oppler and operated on by Mikulicz. Female, aged forty-four, had suffered for over a year with repeated attacks of gastric pain and vomiting. Marked dilatation of the stomach. Grew suddenly worse and vomited constantly without relief. Operation revealed the duodenum blocked with gall stones. Gastro-enterostomy was performed and the patient recovered.

MONPROFIT. 1899. Bull. Soc. anat. de Paris, lxxii, pp. 488–492.

Female, aged fifty-eight. Symptoms of cholelithiasis for thirteen years. Icterus from time to time. Lately the stomach was unable to retain any food. A diagnosis of cancer of the pylorus or occlusion due to old adhesions was made. Operation revealed an enormously dilated stomach and insuperable adhesions uniting gall-bladder, liver, pylorus and duodenum together. Death in forty-eight hours. Autopsy revealed the adhesions before mentioned. A medium sized gall-stone was found in a thickened gall-bladder. Two fistulous tracks were found leading from the pyloric end of the stomach, one passing into the gall-bladder, the other stopping short in the adhesions near the base of the gall-bladder. A stone one cm. in diameter was found. A fold of mucous membrane separated it from the cavity of the stomach and another from that of the duodenum. It blocked up the orifice so completely that liquids could not be forced past it.

LABADIE LAGRAVE ET MADELAINE. 1898. Complications de la lithiase biliare. Rev. gén. d. clin. et de thérap., Paris, xii, pp. 401–407.

Patient was a woman, aged seventy-two, who had suffered for years from digestive disturbances, attended with severe vomiting and periods of absolute constipation. On admission to hospital on October 10, 1896, she was very cachetic and showed signs of a dilated stomach. On November 8th, signs of obstruction appeared; vomiting was very frequent and was bilious in character. The stools were very small and fœtid. She died comatose on November 14th. Autopsy revealed strong old adhesions between the liver, gall-bladder, duodenum, and colon. On opening the duodenum a large bimucous fistula was found between it and the gall

bladder, in which a large calculus lay which projected 3 cm. into the intestine. Above the fistula the gut was narrowed by cicatricial contraction and immediately above this the first part of the duodenum was dilated. Stone and cicatrix probably reduced the lumen by four-fifths.

FLEISCHAUER, C. 1899. Über einen seltenen Fall von Pylorusstenose. Deutsche med. Wchnschr., xxv, s. 273.

Patient, a woman aged thirty-seven, had suffered from intermittent gastric pain and vomiting for about a year. Emaciation was marked. Towards the last the symptoms became almost constant, and signs of ileus made their appearance. A tumor could be felt at the pyloric end of the stomach, and the stomach was very dilated. The diagnosis was pyloric stenosis, probably due to malignancy. Operation revealed conglomerate adhesions uniting liver, gall-bladder, colon, pylorus and duodenum. The gall-bladder was opened and forty-five stones removed. While an attempt was being made with forceps to reach and dislodge a large stone deeply impacted, it crumbled and the pieces fell into the stomach. The stone was as large as a pigeon's egg, and had been impacted transversely in the pyloric orifice which it had completely obstructed. The pylorus was extirpated and the patient recovered.

PILCHER, LEWIS STEPHEN. 1902. Intestinal obstruction due to gall-stones. Med. News, N. Y., lxxx, February 28th, pp. 256–258.

Reports a case occurring in a woman, aged sixty, who suffered from acute intestinal obstruction due to a gall-stone impacted at the jejuno-duodenal junction. Operation: Incision and removal of the stone; recovery.

FIEDLER, A. 1880. Über Gallensteine. Wien. med. Bl., iii, ss. 1229–1232, etc.

Female, aged sixty-six, suffered from chills and epigastric pain for a year. Stomach suddenly became distended and constant vomiting of dark, bitter, bloody material followed. Collapse. Improved for eight days and then suffered from a relapse. Vomiting very frequent and copious. A hard tumor was felt in the pyloric region. The next day the tumor had disappeared and the symptoms passed away. Finally a stone weighing twelve grams was passed per anum. He assumes that the stone had occluded the upper part of the duodenum and was passed spontaneously.

SCHUELE, A. 1894. Über einen Fall von duodenal Stenose durch einen Gallenstein. Berl. klin. Wchnschr., xxxi, November 5th, ss. 1015–1017.

A female, age thirty-five, showed gastroptosis, dilated stomach and motor insufficiency. Sudden collapse occurred with severe epigastric pain, leading to a suspicion of perforation of a gastric ulcer. No peritonitis developed, but stomach became markedly distended with bile. Meteorism and peristalsis of small intestines were absent, no constipation, no ileus. The symptoms were relieved in a few days spontaneously, and she finally passed per anum a gall-stone 2.7 cm., by 9 cm. in circumference, which weighed 4.5 grams. He thinks that the collapse was due to the perforation of the stone into the duodenum, and that the stones mechanically obstructed that portion of the intestine for a few days.

MILES, E. J. 1861. Report of a case of sarcina ventriculi with vomiting of gall-stones. Lancet, Lond., i, 1861, January 19th, pp. 57–58.

Female, aged fifty-six. History of bilious headaches, epigastric pain, and vomiting lasting for four years. Vomited matter contained sarcinæ and torulæ. Sudden acute crisis of epigastric pain and pain over liver and gall-bladder. This was relieved by vomiting a large gall-stone seven-tenths by six-tenths of an inch. Great improvement followed in two weeks by another attack, which was also relieved by vomiting another stone of similar size.

OBSTRUCTION FROM WITHIN THE LUMEN.

(b) Partial

NAUNYN, B. 1896. A treatise on cholelithiasis; translated by Arch. E. Garrod, London, p. 152.

Mentions that Schreiber had under treatment at Koenigsberg, a woman, aged twenty-nine, who had suffered for six months with dilated stomach and symptoms of pyloric stenosis. Mikulicz operated and removed a gall-stone larger than a thumb joint from the base of a pyloric ulcer.

BOUVERET, J. 1896. Stenose du pylore adhérent á la vésicule calculeuse. Rev. de med., Paris, xvi, January 10th, pp. 1–16.

Male, aged sixty-four. For nine years had severe gastric crises which ceased after expelling a gall-stone per anum. Became emaciated and showed marked gastrectasia. Operation by Poncet revealed adhesions around gall-bladder, pylorus and duodenum. Stomach was incised to explore a small nodular tumor in pylorus, which turned out to be a large gall-stone lying partly in the pylorus and partly in a fistula leading from gut to the gall-bladder. Stone was removed. The patient died from internal hæmorrhage on the third day after operation.

TUPPER, PAUL Y. 1903. Complete obstruction of the first portion of the duodenum due to gall-stones. Interstate M. J., St. Louis, x, pp. 590–596.

Patient, a woman thirty-one years old, with a history of three attacks of epigastric pain, and vomiting lasting over a period of six years. Jaundice followed the last attack. Lately has suffered frequently from epigastric pain and a feeling of stomach distension and has vomited almost regularly from half an hour to two hours after every meal. Has lost thirty-four pounds in four months. Operation was performed under a diagnosis of malignant stenosis of the pylorus. Conglomerate adhesions were found binding the gall bladder, stomach,

duodenum and colon. The stomach was opened to determine the site of the obstruction. The pylorus was patent and the finger passed into the duodenum detected a large mass of facetted gall-stones, which were tightly impacted. Eighteen were removed through the stomach wound and the rest passed along the duodenum as the impaction was broken up. The stomach was closed up, and the patient recovered. Subsequently the patient suffered from several attacks of gall-stone colic.

GRAHAM, J. E. 1897. The symptoms and diagnosis of cholelithiasis. Brit. M. J., Lond., ii, October 30, 1897, p. 1240.

The case, a woman aged fifty, showed symptoms of gastrectasia and gastric ulcer. Had suffered from many attacks of biliary colic. Was suddenly taken with severe vomiting which continued off and on for three months, when she died. Autopsy showed a calculus in the ampulla of Vater which partially obstructed the flow of bile and diminished the lumen of the duodenum.

GOLLINGER, EMIL. 1903. Über Darmverschluss durch Gallensteine. Diss. Freiburg, i, Br., ss. 38.

Reports a case in the Freiburg clinic, operated on by Kraske. A woman, aged forty-three, had suffered for two years from gastric crises evidently connected with the gall-bladder. Typical signs of gastrectasia made their appearance. A pyloric tumor was felt and cancer suspected. The tumor was very movable.

On operation the tumor was hard to find. At last it was found in the first part of the duodenum immediately below the pylorus. An incision was made into the gut, and a stone with two facets removed. Recovery complete, with entire disappearance of all symptoms.

DUFOUR, HENRI. 1901. Enclavement d'un gros calcul biliare dans le duodenum sans phénoménes d'obstruction, etc. Bull. et mém. Soc. anat. de Paris, lxxvi, pp. 546–549.

A woman, aged fifty years, suffered from fever and diarrhœa. She died of marasums. Diagnosis of arterial sclerosis and sclerotic kidneys. Autopsy showed a dilated stomach. The first part of the duodenum was obstructed by a gall-stone 21 mm. in its largest circumference and 34 mm. long. It lay in a depression on the posterior wall. A bimucous fistula was present about 2 cm. from the pyloric ring.

The interesting features of the case are the absence of symptoms, such as vomiting, pain, and those of obstruction.

### II. OBSTRUCTION FROM WITHOUT THE LUMEN

#### (*a*) Complete

OLLENDORF, KURT. 1906. Plötzliches Auftreten von Gallensteinileus ohne unmittelbare vorhergehende nachweisbare Störungen in den Gallenwegen. Deutsche med. Wchnschr., Leip. u. Berl., xxxii, ss. 503–504.

#### (*b*) Partial

PEPPER, WILLIAM. 1857. Cases of diseased gall-bladder, etc., Am. J. M. Sc., xxxiii, pp. 13–25.

OGLE, J. W. 1868. Upon certain morbid conditions of the appendages of the liver. Tr. Path. Soc., Lond., iii, pp. 177–207.

WHITE, HALE. 1886. A case of gall-stones contained in a gall-bladder, which had a fistulous communication with the duodenum and set up inflammatory thickening of the pylorus. Tr. Path. Soc., Lond., xxxvii, pp. 280–281.

MADER. 1888. Dilatatio ventriculi in Folge calculöser Vereiterung der Gallenblase, mit Perforation in der Pylorisring wodurch Verdickung desselben und scharfe Abknickung enstand. Tod. Ber. d. k. k. Krankenanst. Rudolfstiftung in Wien, (1887), s. 330.

GRUNDZACH, J. 1891. Über Gallensteine im Magen. Beitrag zur Aetiolog in der Magenerweiterung. Wien. med. Presse, xxxii, No. 32, ss. 1089–1091.

HOCHHAUS, HEINRICH. 1891. Operativer Beitrag . . . Über Magenerweiterung nach Duodenalstenosis. Berl. klin. Wchnschr., xxviii, No. 22, s. 551.

VILLARD. 1896. Calcul du choledoque; obstruction duodénale par ahdérences péritonéales. Lyon méd., lxxxii, pp. 527–529.

WEGELE, CARL. 1898. Zur Diagnose der durch cholelithiasis bedingten Duodenalstenose. München. med. Wchnschr., xlv, Ap. 19, ss. 481–482.

FLEINER, WILHELM. 1900. Über Gallenblasenentzündung und davon abhängige Magendarmstörungen. München. med. Wchnschr., xlvii, ss. 1291–1297.

# LEVER ACTION IN THE PRODUCTION OF TRAUMATIC DISLOCATION[1]

By GWILYM G. DAVIS, M. D., Philadelphia

DISLOCATIONS, when resulting from traumatism to a healthy joint, may be produced by direct or indirect violence, the latter probably being the more frequent cause. When direct violence is the cause, the blow falls on the bone, which is carried in the direction of the violence and tears the restraining ligamentous bands. We should remember that the ligaments are composed of inelastic fibrous tissue and that when the bone tears them it leaves an opening equal in size to the bone that passed through it. Therefore, if the disturbing element of muscular contraction be eliminated, dislocations produced in such a manner ought to be readily reduced because of the large opening in the capsule; and all that is necessary to reduce them is to put the part in approximately the position it was in when the bone made its exit, and push or pull it back into its socket through the same opening it made in coming out. This is found to be true in practice. In these luxations by direct violence every restraining band is torn, and the dislocated bone can be readily replaced and again as readily displaced. In many cases, even the muscles may be so torn and disabled as practically to be eliminated as obstacles to replacement. This class of dislocations rarely gives rise to difficulties in reduction, and their pathology is evident, therefore we may dismiss them from consideration.

The other class of cases is, however, entirely different. They are different in the mode of their production and are accompanied by entirely different lesions. They are often troublesome and difficult to reduce and require methods of treatment which are very definite in character. In these indirect luxations, while the traumatism or blow may be direct, the rupturing force is indirect. In the direct luxations the luxated bone is displaced in the direction of the traumatism and all restraining structures are ruthlessly torn away, but in these indirect luxations the bone is usually displaced in a direction opposite or different from that of the vulnerating force. This translation or change of direction is due to the bone acting as a lever, so that the force being exerted at one end of the lever, the lesion is manifested at the other end. This being so, causes these indirect luxations to assume a more or less stereotyped or orthodox form for each separate joint. This fact enables us to systematize these luxations, so that their pathology and their treatment can be more readily understood and mastered.

The difficulty which is encountered in endeavoring to master the subject of luxations, and the diversity of opinion which is held as regards every aspect of their method of production, the character of the lesions present, and the methods of reduction, are, to my mind, due to the prevailing custom of studying these joint luxations as separate individuals instead of recognizing the basic principles governing them.

When a joint is subjected to traumatism, this traumatism is exerted not on an immovable part but on a movable one. Therefore, when the impact is received the parts move and the force is deflected. This deflection is of a definite character for each individual joint, but in nearly all the joints the deflection is a manifestation of lever action.

There are three classes of levers.

Class 1. The fulcrum is between the power and resistance. (Fig. 1.)

Class 2. The resistance is between the power and the fulcrum. (Fig. 2.)

Class 3. The power is between the resistance and fulcrum. (Fig. 3.)

In most luxations of the long bones, the displacement is produced by a lever action of the first class, more rarely of the second class, and when of the third class, as the power and resistance move together in the same direction, they resemble the luxations by direct violence.

Bones are prevented from being readily luxated by the restraining influence of the contact of the soft parts when the joint is

[1] Read by title before the American Surgical Association, Montreal, May, 1912.

Fig. 1. Lever of first class.

Fig. 2. Lever of second class.

Fig. 3. Lever of third class.

flexed, and by the fibrous ligaments when the joint is extended or rotated. When joints are flexed there is no strain on them, and in extension the only restraining structures — if muscular action is eliminated, as it is — are the ligaments. When a luxation occurs, the luxated bone acts as a lever, and an adjacent bone, or in rare cases, a ligament, acts as a fulcrum.

The primary movements of joints are gliding, hinge, and rotary. In a dislocation of a gliding joint there is no lever action because the surfaces are simply displaced laterally. Hinge and rotary joints are usually displaced by lever action in which the fulcrum is bony. In some joints a rotary force may utilize a ligament as a fulcrum, but it is rare. The joints which possess a more or less pure hinge action are the most numerous. They embrace mainly the phalangeal joints of the hands and feet, the elbows, knees, and ankles.

In these joints, when the joint is flexed and the hinge closed, the contact of the soft parts stops motion before the strain comes on the ligaments. When the joint is extended and the hinge opened, the bone moves until it strikes the adjacent bone and further movements are prevented by ligaments. For a luxation to be produced, all that is required is for the force to continue acting after the ligaments have been made tense. That this is the mechanism of production of luxations in hinge joints will, I think, be evident from a consideration of the separate joints.

Consider a phalangeal joint of one of the fingers. The ligaments are so placed as to prevent extension much beyond a straight line if, as in catching a base ball, the distal phalanx is violently hyperextended it acts as a lever of the first class, its base resting on the neck of the proximal phalanx as a fulcrum and the ligaments forming the resistance beyond. (Fig. 4.) This is the mechanism of the luxations of all the phalanges, both of the fingers and toes, and of most of the metatarso and metacarpo phalangeal joints, especially of that notorious one of the thumb. To reduce such luxations, all that is usually necessary is to flex the hyperextended bone back into place. The only difficulty experienced is in the case of the metatarso and metacarpo phalangeal joints. In these joints, the lateral ligamentous structures are so much increased in size by the addition of the tendons of the short intrinsic muscles and slips from the palmar and plantar fascias that they act as buttonholes to prevent the reposition of the displaced head.

When we consider the elbow joint, we find its main movement a hinge one. When it is hyperextended we find a lever action of the second class produced. (Fig. 5.) When the joint is hyperextended the olecranon comes in contact with the lower end of the humerus as a fulcrum, and the power being applied at the distal end of the forearm ruptures the ligaments on the anterior and lateral surfaces of the joint.

This is what occurs when a man falling on his outstretched arm hyperextends his elbow. The same mechanism of hyperextension causes luxation of the knee, only a lever action of the first class results, the fulcrum being between the power and resistance. The same is the case in the ankle.

When we come to consider the ball and socket joints, especially the shoulder and hip, we find that their basic movement is a to and fro one, a lateral flexion and extension which we name adduction and abduction. The shoulder joint is luxated more frequently than any other in the body. It is a typical ball and socket joint.

The shoulder is a more movable joint than the hip. The femur articulates directly with the trunk, but the humerus articulates with an intermediate bone, the scapula. The consequence of this is that the traumatic force is diverted by the movement of the parts in response to the blow, and what appear like direct luxations, are really indirect luxations. If they were true direct luxations, we would

Fig. 4.

Fig. 5.

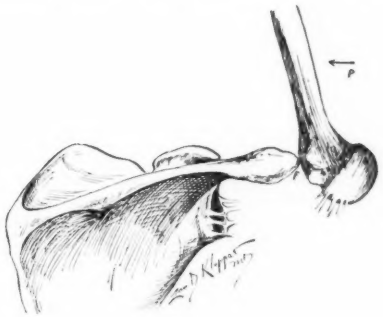

Fig. 6.

Fig. 4. Luxation of the phalanges. Fulcrum formed by the edge of the distal phalanx resting on the neck of the proximal one. Lever action of first class.

Fig. 5. Luxation of elbow. Fulcrum formed by the olecranon process pressing against the lower end of the humerus. Lever action of second class.

Fig. 6. Luxation of shoulder. Fulcrum formed by the acromion process pressing against the greater tuberosity of the humerus. Lever action of first class.

find them heterogeneous in character and corresponding to the varying direction of the injury. If, however, they are indirect luxations, then, being the result of lever action, they must be more regular in character because the lever action can only be effective when the parts are in certain definite positions. On examining the shoulder to discover where lever action can be obtained, we find that when the arm is brought forward across the chest, downward to the side, or downward and backward, it comes in contact with the trunk, and as no proper fulcrum is obtainable the arm cannot be luxated by leverage when in these positions. When, however, the arm is raised, hyperabduction causes the greater tuberosity to impinge on the acromion process which acts as a bony fulcrum, (Fig. 6.) and a continuance of the motion ruptures the capsule on the side opposite. This is the only position in which an effective fulcrum can be obtained, and therefore the site of capsular rupture and exit of the head should always be at the same spot; and this I believe to be practically the case. There is practically but one luxation of the shoulder and that is a sub-coracoid. All other luxations are simply rare and unusual injuries due to more or less peculiar forms of traumatism. If this is so, then is it not a mistake to becloud the subject in teaching, by dilating on the various possible luxations, and fail to make the student realize that he should know thoroughly one luxation — subcoracoid — and that this is the one he will encounter in practice?

Let us examine the mechanism of the production of this luxation. For it to occur, the arm must be in abduction. It is instinctive for the arm to be outstretched when danger or injury threatens. The forearm may be flexed, but the arm will be abducted. If a man falls from a height or from a moving train, it is easy to see that he will strike on his outstretched hand or elbow, the body continuing to move will rotate at the acromion process as a fulcrum, and the head of the humerus will be pried out of the socket. Dislocations occur, however, from blows in the region of the shoulder. Even here the effect, though not so evident, is still indirect. The dislocating blow is not received from in front or below, but from above and behind. If the hand happens to be fixed, say it is grasping an object, or, I believe, even in those cases in which the hand is not fixed, the blow causes descent and moving forward of the shoulder and, as the proximal end of the humerus descends and moves forward, the distal end moves up and backward. By this mechanism the strain is put on the same portion of the capsule as when the man falls on the outstretched arm or hand, and the resultant lesion is the same. The lesion produced is a rupture of the capsule from the base of the coracoid process down the front of the joint to or a little beyond the insertion of the long head of the triceps at the

Fig. 7.

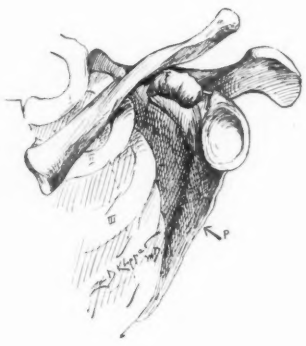

Fig. 8.

Fig. 9.

Fig. 7. Luxation of hip. Fulcrum formed by the rim of the acetabulum and greater trochanter. Lever action of first class.

Fig. 8. Luxation of acromial end of clavicle. The coracoid process coming into contact with the under surface of the clavicle forms the fulcrum. Lever action of first class.

Fig. 9. Luxation of sternal end of clavicle. The lower surface of the clavicle resting on the first rib forms a fulcrum. Lever action of first class.

lower edge of the glenoid cavity. The anterior extremity of the acromion process comes directly over the middle of the glenoid cavity. From this point, the bone passes back to become the spine of the scapula. When, therefore, the head is in its socket and the greater tuberosity is pressing on the acromion previous to the production of a dislocation, the shaft of the humerus is pointing downward and forward. As abduction increases, the scapula is pressed firmly against the thorax, and the head presses against the anterior portion of the capsule. When the arm is in extreme abduction, the long head of the triceps is applied closely to the under surface of the capsule and prevents the head from emerging at that point, so it slips through in front of it. The capsule is torn loose from the rim of the glenoid process up to the base of the coracoid process, and the subscapularis muscle is sometimes torn or loosened from the scapular neck beneath. In the primary injury, the remainder of the capsule is untorn. The coracoid process has attached to it the coraco-brachial and short head of the biceps muscles, and the coracohumeral ligament. Beneath and a little to the outer side is the glenohumeral ligament and the long head of the biceps going to the top of the glenoid process. These structures tend to aid in keeping this portion of the capsule intact. If, however, violent and injudicious movements are imparted to the head of the bone, as frequently occurs in attempts at reduction, the rip in the capsule extends upward beneath the coracoid process and even backward far enough to tear the posterior part of the capsule as well. If this is the mechanism of the production and the conditions present, then, to reduce this luxation, it is only necessary to do four things. First, eliminate the obstruction of the muscles by an anæsthetic, traction or other means. Second, place the arm in a position approximating that which it occupied when it came out; that is, upward and backward. Third, rotate the humerus until the

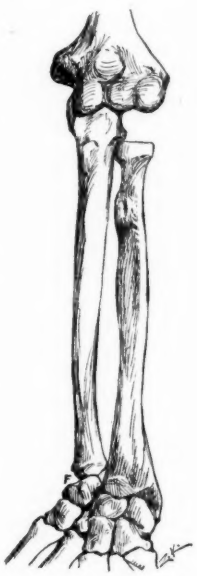

Fig. 10. Luxation of upper end of radius. Fulcrum is formed by the lower end of the ulna resting on the carpus. Lever action of first class.

rent in the capsule is open to its widest extent. Fourth, push or pull the head toward the glenoid cavity. A failure to replace is due to the failure to perform these four procedures. In the Henry H. Smith or Kocher method, dependence is placed on the integrity of the upper or posterior portion of the capsule to act as a ligamentous fulcrum to rotate the head out from the side of the chest, and it fails if these ligaments are torn.

In another ball and socket joint (the hip), the lever mechanism has been so well pointed out by Allis that it needs only to be mentioned. When the femur is hyperabducted, the neck impinges on the rim of the acetabulum and the great trochanter strikes the ilium immediately above; and so, a long bony fulcrum is formed and the capsule ruptured at its lower portion. (Fig. 7.) The hip can also be luxated by strong internal rotation when in an adducted and flexed position. Here the strong Y or iliofemoral is the fulcrum and the rupture is posterior and higher up than in luxation by hyperabduction. Reduction is accomplished much as in the shoulder. Eliminate muscular action by an anæsthetic or other means; relax the structures by adducting or abducting the femur; rotate the limb until the rent in the capsule is opened to its full extent; and finally push or pull the head into the socket. The head can also be guided into the socket by flexing and adducting the femur, then externally rotating it and bringing the limb down. This is practically the method of circumduction and uses the iliofemoral, or Y ligament, as a fulcrum to rotate the head into place.

The lever principle is also evident in other dislocations. For instance, the acromial end of the clavicle is displaced upward by the scapula, (Fig. 8.) rotating on a fulcrum formed by the base of the coracoid process coming into contact with the under surface of the clavicle. The sternal end of the clavicle is dislocated upward and forward by the first rib acting as a fulcrum. (Fig. 9.) The lower jaw is luxated by rotating around a ligamentous fulcrum formed by the spheno and stylomandibular ligaments. In dislocation of the vertebræ the lever principle is not quite so evident, but frequently a luxation of one side is produced by a revolving of the displaced bone around an axis formed by the articulation of the opposite side as a fulcrum.

In the rotary joints, the lever principle is well shown in the dislocation of the head of the radius from beneath the orbicular or, as I prefer to call it, the Y ligament. When the hand is strongly flexed to the ulnar side, the lower end of the ulna acts as a fulcrum and the radius is deliberately drawn downward. (Fig. 10.) This, aided by supination and the traction of the biceps, readily luxated the head of the bone; of course it comes forward.

In conclusion, I would say that the main object of the paper is to see if we cannot study luxations more systematically, instead of individually, and to understand better the mechanism of their production and thereby simplify the subject and render the efforts at reduction more rational than so often appears to be the case. We can appreciate this when we remember that almost every luxation is produced by hyperabduction or hyperextension. Thus, to luxate the fingers, hyperextend; to luxate the elbow, hyperextend; to luxate the jaw, practically hyperextend; to luxate the shoulder, hyperabduct; to luxate the hip, hyperabduct; to luxate the knee, hyperextend; to luxate the foot, hyperextend; and to luxate the toes, hyperextend.

# TALMA OPERATION FOR CIRRHOSIS OF THE LIVER

## With Report of Cases

By EDGAR A. VANDER VEER, M. D., Albany, New York

IN the British Medical Journal for September 19, 1896, there appeared a communication from David Drummond, M. A., Senior Physician at the Royal Infirmary, Newcastle-on-Tyne; and Rutherford Morison, M.B., Senior Assistant Surgeon, Royal Infirmary, Newcastle-on-Tyne, entitled, "A Case of Ascites Due to Cirrhosis of the Liver, Cured by Operation." In this communication they described the operation of omentopexy, or epipoplexy, as it is performed at the present day, and reported a case of cirrhosis of the liver successfully treated by this method.

At the same time, Talma, of Utrecht, independently of the others, had had the operation performed at his suggestion as early as 1889, and it was described by Lens in 1892, though Talma's first published contribution to the subject was not made until 1898, when it appeared in the Berliner klinische Wochenschrift for September 19, 1898, just two years after the original communication on the subject by Drummond and Morison.

In 1900, Frazier (1), of Philadelphia, and in 1902, Greenough (2), of Boston, had splendid articles on the subject in the American Journal of Medical Sciences; but even these communications failed to arouse the enthusiasm they should.

At the Toronto Meeting of the British Medical Association, held in 1906, Sinclair White (3), Senior Surgeon of the Sheffield Royal Infirmary, presented an exhaustive article on the same theme, with a report of all the cases that had been treated up to that time, some 273 in number, of which 91, or 33.3 per cent, were cured of the ascitic complication.

Later still, Dr. Maurice Richardson (4) presented a paper before the Southern Surgical and Gynecological Association, in December, 1910, on Omentopexy, which has served to draw the attention of the surgical world to the usefulness and practibility of the operation.

Following Richardson's paper, Dr. H. H. Grant (5), of Louisville, collected from the most prominent operators in this country 144 reported operated cases, with the following results:

17, or 11 per cent, died as result of operation.

17, or 11 per cent, are reported as cured after three years.

64, or 44 per cent, are reported improved.

32, or 22 per cent, are reported unimproved.

This paper will appear in the Interstate Medical Journal of St. Louis.

Now the literature is being filled with reports of successful cases, and it will not be long before the operation of omentopexy, or epipoplexy, will have its rightful place in abdominal surgery.

As a rule, in the beginning the cases came to the surgeon as a last resort, when every other method of treatment had failed; so that a favorable outcome in the majority of cases was almost an impossibility. Hence, the after results were very discouraging and the operation fell into discredit. However, the few favorable cases which were referred to the surgeon, and which were greatly benefitted by the operation, served to revive interest in it.

Then, again, other fields of abdominal work were much more inviting, because of their more favorable outcome, and so the operation of omentopexy did not receive the attention it deserved. But with the perfecting of the technique of abdominal operations, this operation will in time receive its due share of recognition.

Perhaps the strongest and most valid objection in the minds of most surgeons has been the fact that ascites is one of the symptoms or results of cirrhosis of the liver, and not the cause. Whatever the objection to that may be, the fact remains that by this operation the ascites can be relieved and the patient

[1] Read before the American Surgical Association, Montreal, May, 1912.

given years of comfort, with apparent relief of the other distressing symptoms of the disease.

Of the theory of the operation, or the anatomical details of the venous circulation of the omentum and liver there is no need to go into detail; it is familiar to you all.

Of the pathology of cirrhosis of the liver and its relation to the success of the operation, much might be said. Mallory (6), in his latest article on cirrhosis of the liver, divides the types of this disease into five groups:

1. Toxic cirrhosis of the liver.
2. Infectious cirrhosis.
3. Pigment cirrhosis.
4. Syphilitic cirrhosis.
5. Alcoholic cirrhosis.

Of these five types, the reports indicate that the most successful cases occur in the last two groups; and the reasons are not difficult to find, because these two types of cases yield best to medical treatment after the stasis in the liver is relieved and the liver cells are given an opportunity to regenerate, which they do best in these two groups of cases, though hardly ever in the other three groups.

I should like to report here briefly three cases of omentopexy, Nos. 1 and 2 in the service of Dr. A. Vander Veer, and No. 3 in my own practice, all at the Albany Hospital.

CASE 1. Mr. J. S., aged 45, saloonkeeper, entered the hospital in May, 1903; after having had several tappings for ascites, was encouraged to have the operation of omentopexy. His kidneys were functionating in a normal manner, but he had all the evidence of myocarditis; no valvular lesions, but any exertion would produce rapid breathing and exhaustion. Aside from this his condition was fairly favorable. Had suffered from abdominal dropsy for some five or six months.

Incision made below umbilicus, and liver, on touch, gave a decided hobnail sensation. The omentum was greatly shortened, and much difficulty was encountered in bringing it into the wound. However, it was found possible to attach considerable portions of it, by means of silkworm-gut sutures, to each side of the incision. Drainage, by glass tube down in the pelvis, was employed.

Patient reacted nicely from the operation. Drainage quite profuse for some 72 hours, then subsided, and glass tube removed and replaced by a wick of iodoform gauze. The patient improved and for a short time it seemed as though he was going to be decidedly benefitted, but he died from apparent exhaustion at the end of the third day. No autopsy was held, but it was not thought to be a case of infection.

It may be said that this first case was not a particularly encouraging one for operation. Among professional friends, the operation was looked upon as rather doubtful and not much encouragement given to repeat it. So that quite two years elapsed before the second patient presented, for whom he was willing to advise surgical intervention. This case was more favorable and in the interim more operative cases were reported.

CASE 2. About 51 years old, of fairly good habits, but presented the evidence of cirrhosis of the liver, with abdominal dropsy, and had been tapped twice.

Incision was made from the ensiform cartilage downward and to the right of the umbilicus, permitting a very free view of the cirrhotic liver and contents of the abdominal cavity. In this case there was plenty of omentum, and he brought up two folds on each side of the upper portion of the incision, four to six inches transversely, forming two terraces, as it were, and suturing to the under surface of the abdominal wall with interrupted silk sutures.

This patient did well; improved decidedly; he and his friends were greatly pleased and one year after the operation he was doing nicely. The patient then moved elsewhere, and the final result in his case was never learned.

Remarks by Dr. A. Vander Veer: "I have removed the ovaries under local anæsthesia successfully, but would hardly be willing to attempt such an operation as omentopexy without giving the patient a general anæsthetic. In neither of these cases was any attempt made to roughen the surface of the liver and spleen, although in the second case the liver was handled quite a bit; but no drainage was employed. The cases were somewhat novel to me. I have talked about them since with the late Dr. Macdonald and other associates, but the pathology being so little understood, there seemed to be somewhat of a reluctance on the part of operators to do the operation."

CASE 3. Mr. B. L., aged 29, born in the United States, commercial traveler. He entered the service of Dr. James F. Rooney, at the Albany Hospital on March 7, 1911, suffering from ascites. He first noticed this condition some six months previous, when he had been tapped and about two gallons of fluid removed. The ascites returned at the end of two months, when he was again tapped and the same amount of fluid removed. The ascites returned once more, and until two weeks before he entered

the hospital, he had been tapped about every third day.

Upon entering the hospital he had the appearance of a pale, emaciated man, with a protuberant abdomen. Physical examination negative, with the exception of a markedly atrophied liver. Past history negative, no alcoholic or syphilitic history obtainable.

Patient kept on medical treatment for two weeks and seemed to gain in strength.

Operation was performed on March 31, 1911. A median incision between the umbilicus and symphysis pubis was made. Upon opening the abdomen there escaped a large amount of straw-colored fluid. Examination of the peritoneal cavity, through the incision, showed a markedly hobnailed condition of the liver. Omentum brought into the incision and as much as possible of the surface of the omentum sutured to the anterior abdominal wall. Rubber drainage tube inserted in the lower angle of the wound, and the wound closed with silkworm-gut sutures.

The patient was slow in recovering from the shock of the operation, but gradually regained his strength. The drainage tube was left in position for ten days and during that time a large amount of fluid escaped. Just how much I am unable to say, as it was allowed to drain into the dressings, which were changed every few hours for the first few days following the operation, and were drenched. No fluid remained in the peritoneal cavity when the tube was removed, and there has been no accumulation of fluid since.

He was discharged from the hospital May 12, 1911, fully recovered and able to return to his work by the first of July, and at the present time has practically recovered his former good health; in fact, to such an extent that he was accepted for life insurance by two of the leading companies of the country.

The technique of the operation as proposed by Talma and carried out by Morison was to open the abdomen between the umbilicus and the ensiform cartilage and suture the anterior surface of the omentum to the opposed parietal peritoneum, at the same time freshening by vigorous gauze rubbing the anterior surfaces of the liver and the spleen. I believe this rubbing to be dangerous, as it interferes unnecessarily with the structure of the organs and therefore does more damage than good.

Narath's (7) modification of the Talma operation is as follows: Through a small incision in the mid-line below the ensiform cartilage the peritoneum is opened, a bunch of omentum is picked up, drawn out and tucked under the skin and stitched in place with a few catgut stitches. The incision in the abdomen is carefully sewed around the base of the omental mass sufficient to close the abdomen, yet avoiding any constriction of the omental mass itself.

Mayo advises making an incision on the right side over the liver and in a line with the deep epigastric and mammary vessels, so as to explore its surface. A second incision is made four inches below this, through the rectus muscle, but not through its posterior sheath. This sheath is extensively separated from the muscle and a portion of the omentum drawn out of the upper incision and, with a pair of forceps, pulled down into the pocket, bringing it directly in contact with the larger vessels.

In two of our cases the incision was made in the median line, between the umbilicus and the symphysis pubis. Through this incision the whole field of the abdominal cavity can be explored, and if by any chance a mistake in diagnosis has been made, it can easily be detected. At the same time we can easily palpate the liver and spleen. Also it enables us to attach more of the surface of the omentum to the parietal peritoneum through the one incision, and the patient is saved the shock of a second incision, as advocated by some operators. Then, too, if by chance the omentum has become shrivelled so as not to extend below the umbilicus, the incision can be lengthened and the omentum gently pulled down until enough of its surface can be attached to the incision to insure a favorable result.

Concerning the anæsthesia, some operators advise the use of a local anæsthetic, claiming for it less shock. But with our present method of administering general anæsthesia, the shock is no greater than under a local one, and the opportunities in the way of allowing us to thoroughly explore the abdomen and take our time with the operation are much more advantageous.

Hence, then, the operation of omentopexy, or epipoplexy, has been in use long enough, and there have been so many successful cases reported, that it is the one to be employed in cirrhosis of the liver, despite the fact that it does not seem rational in theory. But since it is successful in practice, the one great point is to educate the profession up to the fact that the distressing symptom of ascites of the liver

can be greatly ameliorated, if not cured, by operation, and that the earlier the patient reaches the surgeon the better the result.

Although the following conditions are insisted upon by Drummond and Morison, namely: that cases selected for this method of treatment should not be complicated by cardiac, pulmonary or renal disease, and should have survived one or two tappings, still the contra-indications are practically nil. Most of the patients come to us as a last resort, when there is no opportunity to build them up before operating. So that the cases at best are desperate, and we cannot be blamed if they die during or soon after operation. On the other hand, the results in some cases have been so brilliant that they encourage the surgeon to advise the operation even in seemingly hopeless cases.

The question of drainage is also a debatable one, the English surgeons advocating it and the American surgeons opposing it, mainly on the grounds of the liability to sepsis. In view of the fact that in the majority of cases reported in which drainage has not been used, anywhere from two to more tappings subsequent to the operation were required to free the abdomen of fluid, it would seem that the use of drainage, for a few days at least, is desirable. With careful technique and careful after treatment of the patient, the danger of sepsis can be reduced to a minimum, and we run no more risks from sepsis by drainage than we do from frequent tappings. Therefore, I firmly advocate the use of drainage in all cases.

In conclusion, it is my opinion that the operation of omentopexy is a justifiable one and that the ideal technique is, under general anæsthesia, a median incision below the umbilicus, suturing as much of the omentum to the anterior abdominal wall as possible; and, above all, drainage for at least a week. This latter feature I believe to be especially essential in the after treatment.

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# NITROUS OXIDE–OXYGEN–ETHER ANÆSTHESIA: NOTES ON ADMINISTRATION; A PERFECTED APPARATUS[1]

By FREDERIC J. COTTON, A. M., M. D., Boston
First Assistant Surgeon, Boston City Hospital

AND

WALTER M. BOOTHBY, A. M., M. D., Boston
Assistant in Anatomy, Harvard Medical School; Assistant Surgeon, Mt. Sinai Hospital (Boston); Anæsthetist to the Boston City Hospital

PROFESSOR ANDREWS of Chicago, in 1868, and Professor Bert of Paris, in 1879, showed that a mixture of 80 per cent of nitrous oxide and of 20 per cent of oxygen would produce an ideal anæsthesia in many cases. Further experience in the use of nitrous oxide and oxygen showed that for practical work these percentages must be easily variable within wide limits, in order to meet the peculiarities of the case and the stage and duration of the anæsthesia. More recently it has become generally accepted that in some patients, in order to obtain relaxation, a varying amount of ether vapor must be administered in conjunction with the nitrous oxide-oxygen mixture.

All experimental and clinical work has emphasized the fact that a *constant* mixture (rightly proportioned for the particular case in hand) produces a smoother anæsthesia than a mixture of varying composition; in

[1] This research has been performed in part under the grant of a Bullard Fellowship by the Harvard Medical School to W. M. Boothby. Through the courtesy of Prof. W. T. Porter much of the work was done in the Laboratory of Comparative Physiology.

other words it has been shown that an intermittent and irregular supply of either gas does not conduce to a smooth surgical anæsthesia.

Consequently an ideal apparatus must be one that delivers to the patient a mixture of the two gases in any desired constant proportion and at the same time provides for the addition of as much ether vapor as is needed. For practical use such an apparatus must require no more attention from the administrator than is necessary to set the valves controlling the delivery of each gas.

Hewitt of England was the first to develop an apparatus at all applicable to general surgical use. His method of overcoming the terrific pressures of the nitrous oxide and oxygen is to use semi-elastic bags, which are kept more or less full from the high pressure tanks, by means of an intermittent flow of the gases controlled directly by hand valves on the tanks, acting against the high pressures. From these bags the flow of gas to the patient is regulated by a specially constructed and graduated valve that allows definite proportions of gas to pass from each bag, providing the pressures within the same are equal.

In practice it has been found very hard to maintain the two bags evenly and equally distended, even if great pains and constant attention are being given by the operator to the manipulation of the hand valves; therefore the pressure in the two bags varies greatly and, consequently, the mixture actually received by the patient must of necessity vary greatly.

McKesson has recently described an apparatus which, like that of Teter, is built on the Hewitt principle. While McKesson's apparatus is an advance in the development of this type of machine, yet it does not actually accomplish all that it is possible for an apparatus to do, in rendering the anæsthetist free from the trouble of valve manipulation, nor does it allow for the addition of ether vapor in a quantity and with a rapidity sufficient to meet the needs of all cases.

As a result of the inadequacy of any apparatus built on the principle of the Hewitt, we took up, now over a year ago, the study of the problem. We laid down four fundamental requirements which we agreed must be met or the problem given up. These requirements are:

1. There must be an absolutely *regular flow of each gas* at any rate desired, without the necessity of frequent valve manipulation.

2. The flow of the gases must be rendered *visible* so that their proportions can be approximately estimated at a glance.

3. An *efficient method of adding ether vapor* gradually yet rapidly up to any amount, that even an extreme case may require, must be available.

4. The face-piece must be so modified as to be absolutely *air-tight* and also practically self-retaining.

The first point, the crucial one, is to obtain an even flow of nitrous oxide gas from its liquefied form, compressed into steel tanks under a pressure of 700 pounds to the square inch. This necessitates the use of an automatic reducing valve. The same is true of oxygen (although not in liquid form) in similar tanks under a pressure of 1,500 to 1,800 pounds to the square inch. The province of such a valve is to reduce these terrific pressures to a working basis of 20 pounds to the square inch; a good valve is absolutely automatic and requires no attention on the part of the anæsthetist; experience has shown that the reducing valves can be absolutely relied on and that they do not freeze or become otherwise obstructed.

This principle of the automatic reduction of high tank pressures is so fundamental that we consider it essential that this feature be actually an integral part of the apparatus and not secondarily attached to tanks which are then connected with an apparatus designed on the Hewitt type. For general use a tank of moderate size (containing 75 gallons of oxygen and 250 gallons of nitrous oxide) is the most practical and convenient; accordingly we have designed our apparatus for that size of tank. The smaller size can of course be used and is preferable for transportation in house operating.

The second desiratum, namely, rendering

the rate of flow of gases visible, so that the relative proportion of each gas can be estimated at a glance, also assuring the administrator of the fact that the desired flow is actually taking place, has been solved by having *each gas bubble separately through water into a glass mixing chamber.*

The volume of gas delivered to the patient is controlled by means of a hand valve of fine adjustment acting against the *low* pressure delivered by the reducing valve. This is entirely independent of the automatic reducing valve. The hand-valves can be set to give any desired volume, which will continue unaltered for hours; a change in the rate of flow is obtained by simply turning the valve-handle a trifle till such volume per minute as is desired is seen to bubble through the water of the mixing chamber.

The aim of the anæsthetist is to determine as early in the anæsthesia as possible the proportion of nitrous oxide and oxygen suited to the patient under his care. The greater his experience the earlier will he be able to do this with certainty. After this proportion is once ascertained the apparatus will deliver the same mixture as long as desired, thus reducing the work of the anæsthetist to a minimum; in fact it is not uncommon for him to sit for more than half an hour with nothing to do but watch the patient quietly breathing, apparently in a natural sleep, and having no need of either touching the apparatus, the mask, or the patient.

The value of being able to estimate by the eye the relative rates of flow of each gas is of inestimable value. After a brief experience one is enabled to approximate the desired proportion solely by the eye, thus rendering it easier to obtain quickly the constant mixture needed for the particular patient in hand. Further, in difficult cases it greatly helps the anæsthetist to determine whether his patient needs more or less oxygen or nitrous oxide, also in case the patient becomes rapidly cyanotic (and this is not a rare occurrence with beginners) the surgeon can see at a glance that the cause of the difficulty is obstruction of the respiratory passages and not due to an insufficient proportion of oxygen in the mixture being administered to the patient.

The third essential point, which consists in being able, gradually yet rapidly, to add to the respired mixture as much ether vapor as even an extreme case may need, has been met by providing a second chamber, containing ether. The gases, after leaving the mixing chamber, pass to a three-way valve by which they are allowed to pass by the ether chamber entirely, or are made to pass either partly or wholly over the surface of the ether, or they may be forced (if desired) to bubble *through* the ether.

Thus *any amount of ether vapor required*, from the minutest trace to a relatively high percentage *can be almost instantly obtained.*

The possibility of gradually and yet rapidly increasing the strength of the ether vapor is of material advantage, for it allows the anæsthetist to just "catch" the patient within a few seconds after he gives a sudden warning of being "light" by moving the legs, contracting the abdominal wall or showing symptoms of impending vomiting. At such moments one may gradually but rapidly increase the ether percentage to that obtained by bubbling through the ether; after a few respirations the patient is seen to relax or the symptoms of impending vomiting disappear, at which time the ether should be entirely shut off. It is best as a rule at the beginning of trouble indicating a "light" condition to make no change in the rate of flow of the gas or oxygen, for when ether is administered a slight excess of oxygen is desirable; but as soon as the impending trouble is overcome the rate of oxygen may be slightly decreased, or that of nitrous oxide increased depending on the amount of rebreathing desired. In all probability the new mixture will maintain the patient for the rest of the operation in a perfect condition of anæsthesia, possibly without the necessity of again touching the valves.

Because we have emphasized the necessity of having available an appliance by which strong ether vapor can be administered we must not be misunderstood; in at least one quarter of the cases no ether at all will be required; in perhaps another quarter about

two minutes inhalation of ether will be needed during the last stages of the preparation of the patient; in another small proportion an occasional addition of ether vapor for one or two minutes through the course of the administration will be found advisable; only very rarely and in rebellious alcoholic cases will more than a total of ten minutes respiration of ether in addition to the gas mixture be needed for an hour's operation; and even in these difficult cases practically no more ether is needed after the first hour, no matter how long the operation is prolonged. Accordingly, little or no nausea and vomiting follows a properly conducted nitrous oxide-oxygen-ether anæsthesia in a great majority of cases. Of course that small proportion of cases that require the larger amounts of ether do not have such an ideal recovery as those needing very small amounts or none; such recoveries resemble those following the ordinary ether vapor method which Gwathmey has found so desirable.

The cases run somewhat more smoothly, and perhaps with an average decrease in the amount of ether vapor needed, resulting in a more nearly ideal recovery if moderate doses of morphine (gr. 1/8 to 1/4) and of atropine (gr. 1/120 to 1/100) are given hypodermically one half hour before the beginning of the anæsthesia.[1] At the Hospital this is a standing order but if it is omitted for any reason we are not concerned except in the case of bad alcoholics. In other words the preliminary injection of morphine is by no means essential though it is desirable unless contra-indicated by some known peculiarity of the patient.

The fourth point necessary for a gas-oxygen anæsthesia is to exclude even the minutest trace of air from leaking in between the mask and the face. This necessity holds true for every case and must be accomplished in spite of peculiarities of the facial contour or the presence of beard and whiskers. Again we emphasize the fact that such exclusion of air must be absolute and not relative. One of us (B.) has recently described a collar that is not only air-tight but practically self-retaining (Boston Medical and Surgical Journal, 1912, clxvi, 9,328), to which article the reader is refered. To those using this collar we call attention, elsewhere more fully dealt with, of the dangers of positive pressure; the expiratory valve must be so set that an outflow of the gases may occur whenever the pressure inside the mask exceeds 2 mms. of mercury, which is a pressure just sufficient to maintain the rebreathing bag full but not distended.

For an even anæsthesia and as an aid to the avoidance of surgical shock a certain constant amount of rebreathing is of benefit; approximately the rate of flow of the gases should be such that from a quarter to a half of the volume of each respiration is of freshly added gas mixture. Such a proportion reduces to within reasonable limits the expense of gas-oxygen anæsthesia; too much rebreathing is apt to be followed by post-operative discomfort, usually in the form of headache; and it may cause an increase of post-operative nausea and vomiting. Vomiting during the progress of the anæsthesia is often an indication of excessive rebreathing for that particular patient although it may, in comparison with other patients, not appear excessive; at all events, increasing the volume per minute of the gas mixture, frequently clears up the symptoms.

Henderson's excellent series of papers on acapnia and its relationship to surgical shock deserves careful reading. Our observations on the effect of rebreathing, so far as they go, agree clinically with the laboratory findings of Henderson; we hope shortly to be able to adopt more scientific methods in the study of this problem in the clinic. Our observations of the blood pressure under nitrous oxide-oxygen (ether) anæsthesia with moderate rebreathing is that there is a distinct rise not only at the commencement but also throughout the operation. After the removal of the mask with its accompanying necessity for rebreathing there is a distinct and rapid fall in the blood pressure. In two instances, both on very sick and debilitated patients,

[1] In the beginning, following the lead of Crile, we used scopolamin with the morphine. Often an efficient hypnotic, scopolamin has seemed to us too uncertain in its action to be worthy of routine use and we have come to use atropin, which does at least reliably insure us against trouble from excess of mucus.

this fall was sufficient to abolish the radial pulse; the appearance of the patients and their mental attitude remained good; recovery was prompt and within one half hour they were in fine condition and remained so. This picture may very probably be interpreted as due to a temporary relative acapnia. If this should prove to be so it would be very easily dealt with by having the patient rebreathe into a paper bag in addition to routine treatment.

It is necessary once more to emphasize the fact that *a surgical anæsthesia is never obtained when the patient appears in the least degree cyanotic* on account of asphyxial spasm and rigidity. On the contrary the *patient must always be pink.*

We have no sympathy for the surgeon who allows his anæsthetist to beguile him into the belief that cyanosis is necessary for a gas-oxygen anæsthesia and, by permitting it, tacitly to assent to the hypothesis that such a condition is safe. We thoroughly believe that any anæsthesia accompanied by cyanosis is dangerous. Reports of deaths under gas-oxygen are rapidly coming in much to the apparent discredit of the method; they are obviously due to conducting the anæsthesia according to this erroneous idea of the necessity and safety of cyanosis; no deaths have been reported in which the patients color was maintained pink. Neither of us would permit an administration of gas-oxygen with cyanosis in any patient of ours; how any surgeon can or will operate under such conditions we do not understand.

In an earlier paper we suggested that some cases, even when respiring a mixture of gas and oxygen in which the proportion of the latter is sufficient to maintain the patient pink, might even then be brought under too profound influence of nitrous oxide and the anæsthesia be made dangerously deep. Our use of an absolutely air-tight face piece has enabled us to demonstrate that such a condition occurs not seldom but frequently. In fact toward the end of a long operation it is often necessary to use equal parts of oxygen and nitrous oxide.

The symptoms of an overdose of nitrous oxide in the presence of sufficient oxygen to keep the patient pink is, first, stertorous respiration and the onset of an excessive secretion of mucus; unless the percentage of nitrous oxide is decreased the patient's face and hands then take on a death-like pallor (not cyanotic), there is an absolute loss of all the facial reflexes, the respirations become shallow and, probably, the blood pressure falls (that is, the temporal cannot be found so readily although the rate is not excessive). This condition if pushed would probably lead to death from paralysis of the respiratory centre, though we know of no experimental evidence to support this hypothesis.

The point we wish to make is that an excess of nitrous oxide may be given even with a proportion of oxygen that, if respirations were proceeding normally, is sufficient to maintain the patient pink; if a death-like pallor with the other symptoms noted should then supervene while respiring such a mixture the patient is rapidly approaching the danger point of excessive anæsthetisation. In such a condition no time should be lost, for as yet we do not know how soon actual respiratory failure and death may occur. In brief the mask should be removed and if necessary artificial respiration instituted together with the administration of oxygen.

We do not wish to imply that this method of anæsthesia is more dangerous than that of straight ether, in fact, we firmly believe that it is the safest when in proper hands. We have had no serious trouble but believe trouble might have developed had we not recognized and appreciated the signs of excessive nitrous oxide dosage. The use of nitrous oxide for prolonged anæsthesia is still in its infancy and its danger limits are not well understood; in consequence for several years yet its effects, good and bad, must be carefully watched.

Even a slight degree of cyanosis distinctly increases the general venous ooze from the incision, apparently by decreasing the coagulation time of the blood; we have never observed this to any serious extent and consider the point of only minor importance.

Although the patient is rapidly rendered unconscious (two minutes) by gas-oxygen yet it is nearly ten minutes before the body

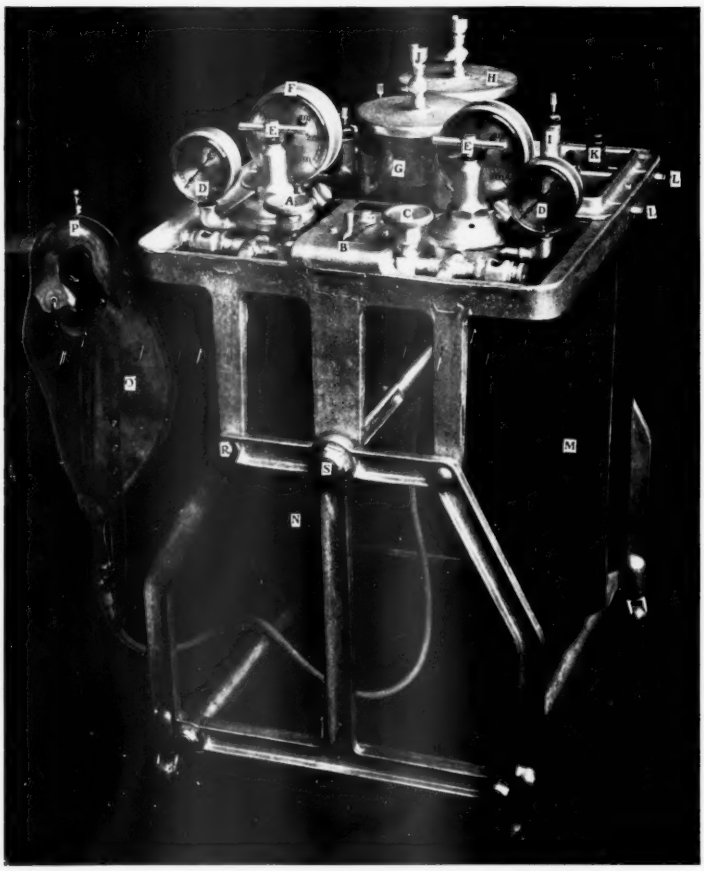


Fig. 1. A. Hand valves: to regulate the volume supply of oxygen; it works against a low pressure of about 25 pounds to the square inch therefore it can be set for and will continue to deliver any constant amount and this can be estimated by seeing the rate of flow as the gas bubbles through the water in the glass mixing chamber (G).

B. Ether valve: when pushed over to the left the mixed gases from G go directly to the patient; when in the centre (as illustrated) the mixed gases pass over the surface of the ether in chamber H; when pushed over to the right the gases must bubble through the ether.

C. Hand valve: to control the volume of nitrous oxide in same manner as A regulates oxygen.

D. Low pressure gauge: the one on the left indicates the pressure of oxygen, and that on the right nitrous oxide, after being automatically reduced by the reducing valve.

E. Regulating handle on the reducing valve: this after being set for the desired low pressure (20 lbs.) does not need to be again touched.

F. High pressure gauge: to show the pressure in the supply tank.

G. Glass mixing chamber: contains water through which each gas bubbles separately thus giving a ready means of estimating at a glance the rate of flow of both the oxygen and the nitrous.

H. The ether chamber: by valve B the gases after being mixed in G are allowed to pass around the ether chamber, or made to pass partly or wholly over the surface of the ether, or forced to bubble through the ether thus adding any desired amount of ether vapor to the respired mixture.

I. One of four valves: introduced so that any one of the tanks may be removed and replaced by a full one without interrupting the use of the apparatus.

J. Cups to fill the chambers with water and ether.

K. Valve on tank.

L. Screw by which each tank is clamped into its yoke.

M. One of the two nitrous oxide tanks on right side.

N. One of the two oxygen tanks on left side.

O. Rebreathing bag.

P. Mask with celluloid face-piece and the Boothby air-tight self-retaining collar.

Q. Two of the four lag bolts which may be removed by unscrewing the thumb nuts on the inside to allow the top of the table to invert into the lower half.

S. Centre axis on which the top half swings.

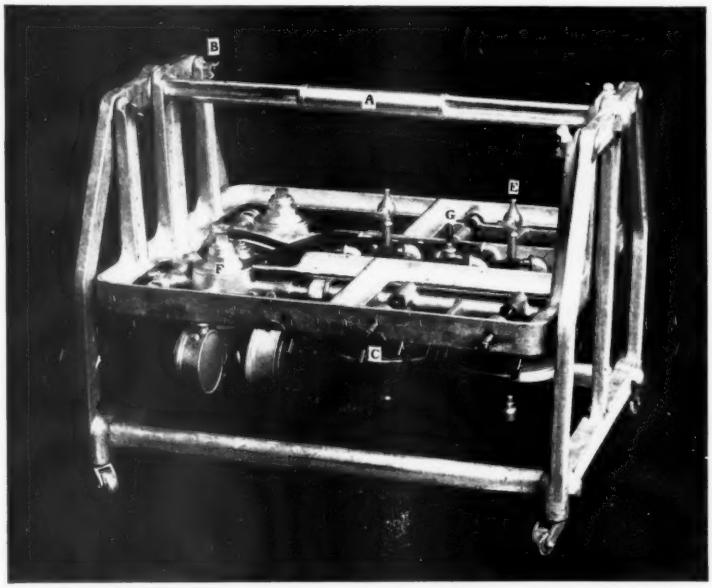


Fig. 2. A. Centre axis on which the top half swings; the middle portion serves as a handle.

B. One of the four thumb nuts which are removed to invert the table.

C. Mixing and ether chamber protected by the frame when top is inverted for transporting.

E. Pet-cocks for drawing off the water and ether from the chamber before inverting.

F. The under side of one of the automatic reducing valves.

G. The metal nipple to which the rubber tube is attached that leads to the rebreathing bag.

Size: Height, 17 inches; length, 22 inches; width, 17¼ inches; weight, 50 pounds (aluminum castings).

is sufficiently saturated with the nitrous oxide to permit the beginning of an abdominal operation. During this period which may be occupied by the preparation and draping of the patient, we allow the anæsthetist to depart somewhat from our rule in regard to avoidance of cyanosis; but even here we permit only the slightest degree of duskiness and never entertain the possibility of deep cyanosis. By the time the incision is made the patient must be actually pink and remain so throughout the operation. If then a mixture of nitrous oxide and oxygen with a proportion of the latter sufficient to maintain the patient pink will not produce sufficient relaxation to meet the demands of the surgeon the anæsthetist must add ether vapor till relaxation is complete.

For the best results close co-operation on the part of the surgeon and the anæsthetist is essential. During the greater part of the majority of operations complete relaxation is not needed; when such relaxation is required by the surgeon he should so inform his anæsthetist who will be able within two minutes, by the proper administration of ether, to provide the same; as soon as such need is over the ether may be discontinued.

A cyanotic condition of the patient, however, sometimes quickly develops even with an evidently liberal supply of oxygen as shown by the flow through the mixing chamber. In such cases the trouble is without question an obstruction of the air passages and must be quickly remedied. Contrary to the generally accepted opinion *cheek and tongue obstruction of the air passages is extremely common under gas-oxygen anæsthesia and its prevention is absolutely essential.* The most frequent cause is an obstruction of the nares together with a valve like action of the

lips or cheeks against the teeth that occurs in mouth breathing when there is muscular relaxation. A ready means of overcoming such a condition is to slip up under the face-piece or collar a piece of gauze or a thin ribbon retractor into the angle of the mouth to keep the lips apart and the cheek away from the teeth; or pieces of rubber tubing about six inches long, guarded by safety-pins, may be introduced through the nares into the oro-pharynx. In rare cases the tongue may drop back and cause obstruction in spite of every effort to prevent the same by holding the jaw forward; in such cases a silk-worm-gut stitch should be passed through the tongue and brought out under the collar, with a dental mouth prop placed between the teeth to prevent biting of the tongue. An absolutely free air passage for the gases must always be maintained; any slight obstruction, most common on inspiration, causes a labored respiration under which conditions a smooth anæsthesia is impossible, besides throwing an extra exertion onto the patient.

Teter has, at various times, recommended an increase of pressure in the mask and in the rebreathing bag as an aid to inducing a more profound nitrous oxide anæsthesia, basing his claims for the procedure on the well known experiments of Paul Bert in 1879. In one of our earlier articles we disagreed with Teter as to the advantages of increased tension of the respired mixture, on the basis of its causing labored abdominal respiration which interferes with the surgeon's work. We wish now to go further and strongly discountenance the use of *positive pressure because it is a dangerous procedure*. In the first place the Bert and Teter methods are not comparable; Bert increased the pressure of the mixed gases as breathed to about 20 per cent of an atmosphere, but this was done in a pressure chamber in which the patient as well as the operator and assistants were likewise placed. In other words the increased intra-pulmonary pressure was compensated for by an equal increase in the atmospheric pressure surrounding the patient's body, thus causing no circulatory disturbance.

It is well known that the right heart is filled from the venæ cavæ on account of a slightly greater pressure within the latter, which, however, under certain surgical conditions may be as low as 10 mms. of mercury; as the cavæ pass for some distance through the thorax where normally there is slight negative pressure, it can be readily understood that an increase in pressure within the thorax (as produced by Teter's method) without a corresponding increase in external atmospheric pressure may hinder the filling of the heart with the consequent evil train of symptoms. An increase of the intra-thoracic pressure above that of the abdominal venæ cavæ will therefore cause sudden death from obstruction of the circulation by preventing the heart from filling. Frantic efforts to save the patient by turning on the oxygen and jamming down the mask renders matters worse.

The theoretical benefit to be obtained from an increase of pressure is less than one per cent in efficiency; accordingly, a procedure involving the dangers of collapse and of sudden death, with such a meagre beneficent return, should not be used.

In practice, therefore, the rebreathing bag should just become taut at the end of an expiration; this corresponds to a pressure of one or two mm. of mercury which is sufficient to open the respiratory valve at the end of the expiration and thus to allow the last part of the expired gases, that part which (as McKesson points out) contains the largest percentage of $Co_2$, to escape into the air.

The experimental apparatus recently described by us,[1] built on the principles enunciated above without regard to lightness and portability, has been most satisfactory and has met all expectations. In that apparatus we included other factors such as an efficient warmer for the gases and an electric motor to drive an air pump in case air should be desired as a carrier of ether vapor instead of the mixture of gas and oxygen. These accessories have been proved useless, and in consequence have been discarded. Because

[1] Cotton and Boothby: Nitrous oxide-oxygen anæsthesia with a description of a new apparatus. Surgery, Gynecology and Obstetrics, xiv, 2, Feb., 1912, 195–211.

gases absorb heat very rapidly we found that by the time they reached the patient their temperature, without any heating apparatus was nearly that of the room; by means of the heater originally described the gases could be delivered 10 to 20 degrees (F) higher. The frequent complaint by the patient, following the use of the heater, of dry parched lips which caused considerable, though of course, not serious discomfort, led us to the conclusion that an efficient heating apparatus was a disadvantage; as an inefficient appliance is an unprofitable complication, we have reversed our former opinion as to the desirability of having an attachment for warming the gases on the apparatus.

An apparatus to meet all the requirements described above must have some size and weight. These items however, have been reduced to their lowest terms by great care in the design and arrangement of the various parts. For the purpose of transportation the apparatus can be collapsed to a reasonable carrying size (height 17″; length 22″; width 17¼″:) by the simple removal of four lag bolts, set up with thumb screws, which allows the top half of the machine to swing down into the lower half; the centre bar or axis acts then as a convenient handle and the framework forms a protecting cage for the valves and the glass chambers. To reduce the weight the patterns have been made as small as is consistent with the strength requisite for hard hospital use and transportation for house operating, and the castings are made of aluminum alloy (except the valves). The carrying weight is just under fifty pounds.

SUMMARY

I. To be safe, effective and suitable for major surgical work a nitrous oxide-oxygen anæsthesia must be so conducted that the patient is never in the least degree cyanotic; on the contrary the patient must always be pink.

II. No attempt should be made to use the dangerous procedure of increasing intrathoracic tension of the gases for the purpose of deepening the anæsthesia.

III. In those cases that cannot be sufficiently relaxed for the purpose in hand by the use of nitrous oxide with a sufficient proportion of oxygen to prevent cyanosis, the anæsthesia should be deepened by the addition of as much ether vapor as may be needed; experience has shown that the total amount of ether used is small and has little and often no effect on the quick and agreeable recovery incident to this form of anæsthesia with its absence of postoperative "surgical shock."

IV. We believe an anæsthesia without cyanosis to be safe in expert hands. The anæsthetist, however, must have skill and experience to recognize the warning signs of too much nitrous oxide even without cyanosis (a picture not striking enough to appear to the tyro) as well as the signs of too much ether.

V. Therefore to be practical for surgical work an apparatus for the administration of nitrous oxide-oxygen-ether anæsthesia must posses the following fundamental features:

1. The apparatus must deliver, *for any length of time, any desired proportion* of nitrous oxide and oxygen, without requiring constant attention from the administrator; in other words the high pressure of the supply tanks must be automatically reduced to an easily controllable working pressure; the importance of this feature necessitates that the reducing valves be an integral part of the apparatus.

2. It must be possible to add *ether vapor in any strength* from the merest trace to a high percentage; and any desired variation in this percentage must be gradually and yet rapidly made.

3. There must be a method of instantly estimating by the eye the approximate proportion of each gas being administered.

4. The face-piece must be not only airtight but practically self-retaining.

5. The apparatus must be strong, light and reasonably portable.

VI. The apparatus herewith described and illustrated is designed to meet the clinical and the physiological requirements of surgical anæsthesia and it effectively overcomes the mechanical difficulties attendant to the successful administration of nitrous oxide-oxygen-ether.

# THE EFFECTS OF URETERAL LIGATION; EXPERIMENTAL AND CLINICAL[1]

J. DELLINGER BARNEY, M. D., BOSTON
Genito-Urinary Surgeon to Out-Patients, Massachusetts General Hospital; Assistant in Genito-Urinary Surgery, Harvard Medical School

DURING the past three years the writer has been carrying on experimental work in the Laboratory of Surgical Research, at the Harvard Medical School, on the effects of sudden and complete occlusion of the ureter by ligature in animals. The results are of importance and interest, but as the work progressed it became evident that the problem was of such magnitude that its various aspects would have to be dealt with separately.

As experimental work is of value chiefly for its bearing upon human problems, it follows that any such investigation must be viewed quite as much from the standpoint of the clinic as of the laboratory. The results of experimental ligature of the ureter are so uniform, and so striking (Figs. 1, 3 and 4) that we have sought to compare them with those of a similar procedure in man. Also, as we have already pointed out, in our forthcoming paper on experimental work, the statements of textbooks are not only conflicting, but largely erroneous. This paper is written in the hope that an analysis of a fairly large group of such cases will settle at least some of the aspects of this problem.

For this purpose the literature was searched with some care and thirty-two cases answering our requirements have been gathered, many of these having been already collected by Sampson, of Albany. Through correspondence with most of the representative surgeons and gynecologists of this country we have gathered together thirty more cases.[2] With a total of sixty-two authentic cases of sudden and complete occlusion of the ureter by the ligature or clamp we feel that deductions from them will be of value.

Of these sixty-two cases the ureteral injury was unilateral in forty-six, bilateral in sixteen, the large majority occurring in the course of a hysterectomy, vaginal or abdominal. In forty-eight the ureters, one or both, were ligated with or without division; in seven the obstruction was produced by a clamp. As by the latter method the ureteral lumen is as suddenly and completely closed as by ligature these cases have been included.

The ureteral injury produced no immediate symptoms whatever (except of course anuria in those of double occlusion) in twenty-six cases or forty-one per cent. Of the unilateral cases ten or twenty-one per cent had no symptoms referable to the injury, either immediate or remote, and all made a full recovery. Were it stated in the reports how long after operation these patients had been followed we might be obliged to modify the figures. The only one about whom we have definite information died nine months later of recurrent malignant disease (for which the original operation was done) and during this time there was nothing to call attention to the injured ureter.

As we see anuria not uncommonly from interference with the function of one kidney either by calculus or other process, this condition was hopefully sought for in the cases of unilateral injury. It occurred but once, the patient dying after thirty-six hours of acute uremia. The rarity of its clinical occurrence is striking, but is entirely in accord with our experimental results. Of thirty-three animals, seven rabbits and twenty-six dogs, whose ureter was ligated, the reno-renal reflex, as evidenced by anuria, did not occur in a single instance.

Anuria was present, as was to be expected, in all of the bilateral cases, and was the only symptom. Its duration was variable, but in no case was it allowed to continue for more than ninety-six hours. In the latter, and in another after forty-eight hours, a double

[2] Our gratitude for their courtesy was expressed at the time to those surgeons and gynecologists who contributed material. As the cases are not to be given here in detail it seems unnecessary, and, in some instances, a breach of confidence to record the names of these gentlemen. The writer wishes, however, to assure them again that his sense of gratitude is none the less keen.

[1] Read at the eleventh annual meeting of the American Urological Association held in New York City, April, 1912.

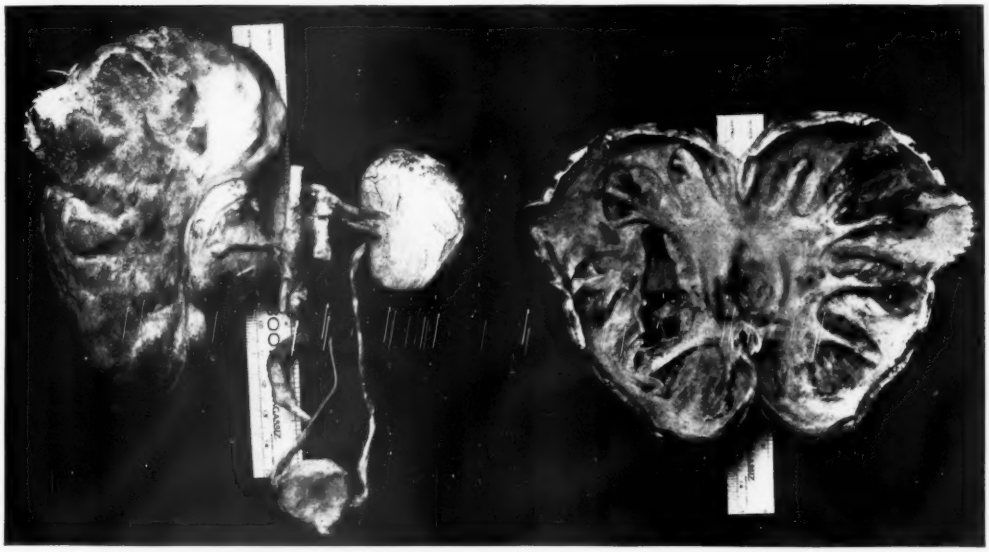

Fig. 1. Dog 6. Two hundred and forty-seven days after ligation of the ureter. This shows a most extreme degree of hydronephrosis 13 cm. in length. Compare the size of the two kidneys. Note great dilatation of pelvis and ureter. Lobulation of kidney well shown. During life enormous vessels anastomosed freely over the hydronephrotic kidney, but are not seen in the photograph owing to the deposit of fibrinous exudate over the organ, the result of perinephritic abscess and pyonephrosis from which the dog died.

In A, near the top of outer border of kidney, and in B, in center of left side, is seen the point at which rupture of sac occurred by necrosis.

In B, note the extensive thinning of cortex, development of interlobular bands, and dilatation of the pelvic outlet.

nephrotomy was performed. Urine was secreted freely in each case, but death occurred in the one after forty-eight hours, and in the other after twenty-four hours. In the others the operator, realizing what had happened, restored the continuity of the ureter by the removal of ligatures or clamps, or by anastomosis. That his attempt to lift Nature to her feet was not always successful is shown by the high mortality of thirty-three per cent. And yet one cannot say that the suppression of urine alone was the determining factor. In none was it long drawn out, and as a matter of fact, this condition may exist for a much longer period of time before death ensues. Morris mentions a case of anuria of seventeen days duration, while another surgeon, with whom we corresponded, saw in consultation a patient who had passed no urine whatever for twenty-three days. Both ended fatally, but they serve as proof that the human system can sometimes make good resistance to this particular onslaught. In the series of cases under consideration the high mortality must be ascribed to other factors such as severe and prolonged operation in a patient already below par, and to whom the ureteral injury was merely the last straw.

In animals we have found that after the elimination of one kidney by the ligation of its ureter, the urine from the healthy side is at first somewhat decreased in amount, but within a few days a compensatory secretion takes place, and the urine may then equal or exceed its former quantity. Such is the case in man, although observations on this point are unfortunately scanty. In the unilateral cases a decrease in the urinary output during the early post-operative period was observed in ten (twenty-one per cent), while in two, in whom this feature was carefully watched, a subsequent rapid rise in the daily amount of urine was noted. In the absence of sufficient data on this point we must assume that of the

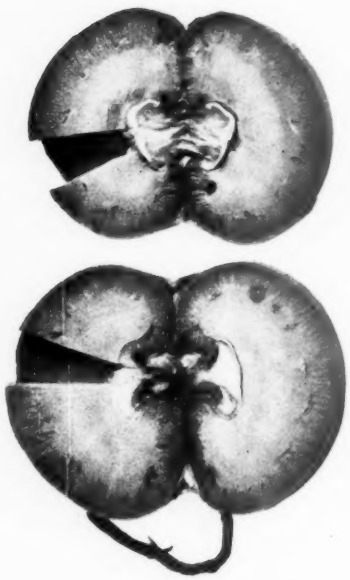

Fig. 2. Dog 5. Eighteen weeks after ligature of ureter. Atrophied kidney above. Note absence of dilatation of pelvis and obliteration of normal markings of kidney.

ten cases in whom one ureter was shut off, and who made a complete recovery, the urinary secretion was at least sufficient to maintain life and health regardless of its quantity.

In two patients having one ureter ligated, the urine was bloody for two or three days after operation. It is possible that the additional work, and hence the increased blood supply of the healthy kidney, gave rise to this condition. In dogs whose urine was carefully examined before and after operation no hematuria was seen. We believe the source of the blood in the clinical cases to be the injured ureter whose walls were bruised and crushed by the ligature. Whatever the cause, hematuria is evidently not common, and we record the facts for what they are worth.

So far as observations could be made in dogs and rabbits ureteral ligation produced no pain or tenderness in the corresponding kidney. In the series under consideration, damage to one ureter gave rise to renal pain or tenderness, or both, in twenty-six per cent. We have not, however, found it remarked that the pain was severe, or protracted, or that the tenderness was more than fleeting. In fact in only one patient was the kidney more than a temporary source of complaint, and in this case the continuance of severe pain necessitated a nephrectomy.

It is significant that in *no* case of bilateral occlusion of the ureter was there any pain or tenderness in the kidneys. Whether this may be explained by an immediate and considerable reduction of the urinary output to which it may give rise, and as a result of which the renal capsule is not stretched, nor the pelvis dilated, we cannot say. We regard such a theory as adequate to explain the facts, and as we have been unable to find any reference to this question in our perusal of the literature, we offer it for your consideration.

In the cases of unilateral injury of the ureter we regard the production of renal pain and tenderness as evidence, with a firm experimental basis, of an immediate and intense renal congestion with a persistence of the secretion of urine by the damaged organ.

Our observations, and those of others, of the kidney whose ureter has been experimentally ligated, have shown this condition of the organ during the first few days after operation. With the formation and development of anastomosing vessels of the renal capsule with others (spermatic, ovarian, suprarenal, and lumbar), new channels are provided for the venous circulation, and the congestion gradually subsides.[1] Furthermore, the kidney, in spite of its handicap, continues to secrete urine for many weeks or months, and refills even though repeatedly emptied. In the absence of confirmatory data the occurrence of these phenomena clinically is uncertain, but we firmly believe that they occur at least in some degree, and we also regard them as the underlying cause of the renal pain and tenderness. Furthermore, by the same argument we can explain the cessation of these symptoms by the establishment of the vascular anastomoses already described.

Contrary to the results obtained experi-

[1] For a full account of such vascular changes in the kidney the reader is referred to our paper on "The Effects of Ligation of the Ureter; An Experimental Study," Trans. Am. Assn. Genito-Urinary Surgeons, 1912.

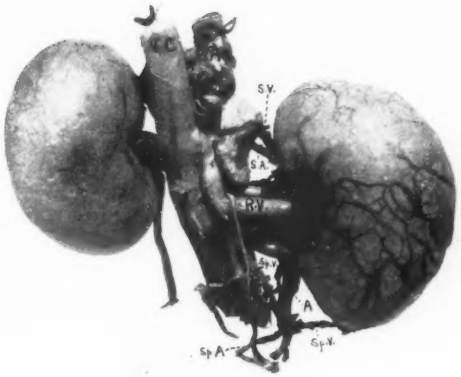


Fig. 3. Dog 26. Eleven days after ligature of ureter. Male. Left hydronephrosis, anterior view. Injection of vessels. Nephroptosis on left. Tortuosity of left ureter, A. Note branch of spermatic vein, S. V., supplying upper pole. V. C., vena cava; Ao., aorta; R. V., renal vein; Sp. A., spermatic artery; S. A., suprarenal artery. No engorgement of vessels of right kidney. Compare with posterior view, Fig. 4.

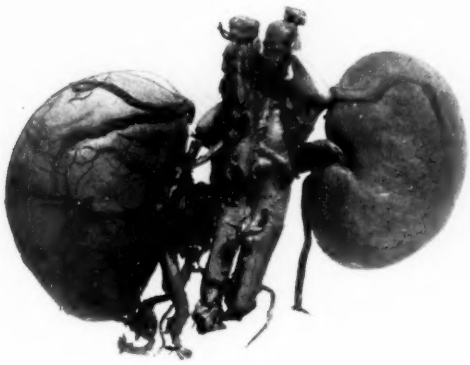

Fig. 4. Dog 26. Eleven days after ligature of the ureter. Left hydronephrosis. Vessels injected. Posterior view. Shows size, number and distribution of vessels on posterior aspect of kidney. Compare with anterior view, Fig. 3.

mentally, ureteral fistulæ established themselves in twenty-four per cent, the urine choosing various points of exit, according to the nature of the operation, seeming to prefer the vagina, but not ignoring the laparotomy wound or even the abdominal cavity. Our work in animals has taught us that a ureter once firmly tied remains closed indefinitely, even when it is not divided beyond the point of ligature. But as in animals we used ligatures of silk or chromic catgut, while in the human plain catgut seems to have been employed, the difference in the results may be thus explained. The ability of the ureteral lumen to re-establish itself is illustrated by the following case:

The right ureter was ligated at the pelvic brim with absorbable catgut. Above this point it was opened and drained for "some time" through an in-lying catheter. On removing the catheter urine drained freely into the bladder, showing that occlusion by absorbable ligature is not permanent.

It seems to us that this case illustrates a point of importance; namely, that if the ureter is intentionally ligated (as it was in some of these cases), the ligature should be of enduring material, such as silk or chromic catgut. Whether it is also divided is not essential. Observations in animals show that in a few weeks Nature replaces the ligature by a firm fibrous closure of the ureteral lumen, giving its extremity a club-shaped appearance.

As some investigators have declared that ureteral ligation in animals results in infection of the corresponding kidney, and as others have denied the allegation, we investigated this point in our own experimental work. Sterile cultures were obtained from the urine of the hydronephrotic kidney in three rabbits after intervals of three days in two, and fifteen days in one, and in two dogs at periods of six and twenty weeks after operation. In the others, with a few exceptions, the absence of infection of the renal sac must be granted if the constantly good health of the animal and the normal appearances of the urine and kidney are of any significance. But it is essential to realize, first, that the urine of normal animals (at least that obtained from the kidney) is rarely if ever infected; and, second, that the animal is selected for experimental purposes on account of its good health.

In man we are handicapped by the absence of one or both of these factors. The patient is generally below par, the operation still further lowers his powers of resistance, and finally the kidney is frequently infected at the

outset. This latter statement is made without corroboration from the history of our cases, but we regard it as an observation whose probability is great.

Renal infection after ureteral occlusion was noted in seven, or fifteen per cent, of these cases, but occurred only in those of unilateral injury. We offer no explanation for its absence in the bilateral series. In the presence of damage to both kidneys its appearance would ordinarily be expected, but the facts do not show it.

All these seven infected organs were removed at varying periods after the primary operation, which, with the nephrectomy necessitated by persistent pain and mentioned elsewhere, gives a total of seventeen per cent in whom the ureteral injury led to a subsequent nephrectomy.

Ligation or clamping of the ureter is, therefore, not to be regarded as the best means of escape from a difficult situation (as it evidently was believed to be in some instances) especially as the mortality of this procedure is found to be 17.8 per cent. But, as was stated with reference to the bilateral injuries, the mortality is not strictly that of the accident. Other factors, already enumerated, cannot be disregarded. We are convinced that if a perfectly normal individual were subjected to the comparatively simple operation of ligation of one ureter the mortality would be low, perhaps nil. Our opinion in this matter is based not alone upon the successful outcome of this operation in animals, but also upon the fact already stated,—that of the forty-six clinical cases, ten, or twenty-one per cent, recovered without symptoms of any sort, while the others (about sixty per cent) successfully outrode the storms of convalescence even though seeking the shelter of a nephrectomy.

We have already remarked that one of our chief interests in this investigation was our ability to strike a parallel between clinical and experimental results. We have shown that hydronephrosis is an almost constant sequel of the experimental ligation of one ureter (Figs. 1, 3, and 4), atrophy of the kidney occurring but once (Fig. 2) in a series of thirty-three animals. In this case there was no engorgement of the capsular vessels or evidence of their anastomosis with others. In all the hydronephroses these vessels were extraordinarily large and numerous, and their relation to others well marked, a feature which we have been able to show in photographs of injected specimens. (Figs. 3 and 4). We were thus led to the conclusion that hydronephrosis is dependent for its development upon the formation and growth of capsular vascular anastomoses. Clinical data on these points are sadly lacking. In only fifteen cases was the subsequent condition of the kidney actually observed. The paucity of material is, however, somewhat compensated for by its quality. In twelve (eighty per cent), hydronephrosis had developed, the size of the renal sac depending on the age of the obstruction. In no instance was the condition of the capsular vessels noted. But as the ureter was released after ten days in the oldest case, and after six days, six days, and five days respectively in the others, whose age entitles them to consideration, we must assume either that no vascular changes had taken place, or that the anxious surgeon, intent only upon the patient's welfare, was blinded to the scientific aspects of the situation.

In two cases note was made of the palpation of a large kidney some days after the accident, but the exact time is not stated. The case of longest duration was operated upon at the end of ten days, and a permanent lumbar ureteral fistula established. The record states that "the secreting part of the kidney was thinned out, forming the wall of a cyst possibly twelve inches in diameter." This has encouraged us to believe that such kidneys would be more frequently found if sought for.

Of the remaining twenty per cent we have no definite knowledge beyond the statement that "no change" had taken place in the kidney.

Therefore, from the data so far obtained, we must acknowledge that ligation or clamping of a ureter in man does not produce hydronephrosis of large size, although the case just cited shows that considerable dilatation may occur even after ten days.

In connection with the incidence of hydronephrosis it has seemed to us important to learn how long a ureter may be occluded

without crippling the functional capacity of the kidney to such an extent that nephrectomy is indicated.

A review of the literature on this point reveals a confliction of opinions, and the statements of those with whom we corresponded leave us still more in the dark. In the presence of such disagreement the data gathered from this series is of value.

In the patient whose ureter was obstructed for ten days and who had a considerable degree of hydronephrosis, the kidney immediately resumed its function, and continued to secrete a large amount of clear, normal urine over a period of many years.

Another kidney, whose ureter was released after six days, secreted normally.

In a third case both ureters were ligated for forty-eight hours. At the end of this time the left ureter was released, and urine appeared in the bladder. The ligature was not removed from the right side until the sixth day, but then normal urine came from it and the patient made a good recovery.

Again, in a patient whose ureter was ligated for five days, the kidney took up its work after the removal of the obstruction.

The facts are then that ureteral occlusion may exist for at least ten days without material harm to the kidney. With our recently acquired knowledge of renal function from the phenolsulphonephthalein test we shall be able to judge each case on its own merits. But we wish to emphasize a point much dwelt on by Guyon, Albarran, and other investigators, and which our own experimental work has taught us; namely, that after the release of a ureter long obstructed, the kidney displays a remarkable recuperative power, and an organ which at first is apparently of little value will prove itself an important factor in the elimination of metabolic waste. Hence we urge the delay of a nephrectomy until the kidney is definitely proven useless.

The aim of this communication has been; first, to draw conclusions based, not on theories, but on facts; and second, to compare as closely as possible clinical and experimental observations. Our conclusions may thus be briefly summarized:

1. Sudden and complete occlusion of one ureter may produce no symptoms whatever, and uninterrupted recovery may ensue in twenty-one per cent of cases, but,—

2. In the event of an injury to both ureters there is complete anuria in all, as is to be expected, whereas,—

3. In the unilateral injuries suppression of urine occurred in only 1.6 per cent.

4. Ureteral fistulæ are developed in twenty-four per cent, their site depending upon the nature of the operation.

5. Where only one ureter is ligated, pain and tenderness in the kidney, usually subsiding spontaneously, is to be expected in twenty-six per cent. It has not been found in cases of bilateral injury.

6. Infection of the kidney produced by the injury to the ureter, or aggravated by it, and necessitating subsequent nephrectomy, occurred in fifteen per cent.

7. Both ureters may be clamped for as long as seventy-two hours with complete recovery after removal of the obstruction, whereas one ureter may be completely blocked for ten days without destroying the integrity of the kidney.

8. Of fifteen patients in whom the subsequent condition of the kidney was investigated, hydronephrosis was observed in eighty per cent, but in no case was this of more than moderate size. In the remainder there was said to be "no change" in the condition of the kidney.

9. The mortality of bilateral occlusion of the ureter is found to be 33.3 per cent, whereas,—

10. In unilateral occlusion the death rate is 17.8 per cent, but in both instances we must consider the influence of other factors, such as the previous condition of the patient, and the severity of the operation.

11. Our investigation of this series of cases shows (*a*) that there is strong probability that many a ureter is ligated without the fact being known, and (*b*) that in the presence of postoperative anuria, and in the absence of localizing symptoms examination of each ureter by the cystoscope may be the only means of determining whether one or both ureters have been occluded.

# EXPERIMENTAL HYDRONEPHROSIS

## Produced by Complete and Incomplete Ligation of the Ureter

By G. D. Scott, M. D., Sullivan, Indiana
From the Anatomical Laboratory, Northwestern University Medical School

THERE are to be found in the text-books the most conflicting statements concerning the pathogenesis of hydronephrosis, and in the literature only the reports of inadequate investigations. These will be reviewed briefly in another place. The investigations to be reported here were begun at the suggestion of Dr. S. W. Ranson. The results of 41 experiments on dogs have been brought to the solution of the following questions:

1st. Would a sudden, complete obstruction of the ureter produce a hydronephrosis?

2d. Would an incomplete or intermittent obstruction to the ureter produce a hydronephrosis?

3d. Which of the above would produce a hydronephrosis more rapidly?

4th. What histological changes would be produced in the kidneys by complete and incomplete or intermittent obstruction of the ureter?

The first part of the problem was partially determined in a former paper (1), and another series of experiments is being conducted to determine if the kidney will regenerate and regain a portion of its function after removal of the obstruction.

*Technique.* Dogs were anæsthetized with ether, and placed midway between the side and abdominal position, so that the intestines fell forwards from the spine. The hair was shaved from the lumbar region and the field of operation washed with soap and water and tincture of iodine applied to the skin without previous rubbing. A small incision, about one inch in length, was made about two inches lateral and parallel to the spines of the vertebræ, just above the crest of the ilium, through the skin, fasciæ, and quadratus lumborum muscle, and the ureter exposed without opening the peritoneum. An aneurism needle carrying a silkworm gut ligature was passed beneath the ureter and the latter was ligatured at varying points below the pelvis of the kidneys. Two ligatures, one about half an inch above the other, were used in a majority of the animals to make sure of a complete obstruction to the ureter. For purpose of producing an intermittent obstruction, a small rubber band was placed around the ureter in such a manner as to constrict the lumen, producing a complete obstruction until the pressure in the pelvis of the kidney became great enough to stretch the rubber band, relax the obstruction, and let the fluid escape. The muscle incision was then closed by a continuous No. 3 catgut

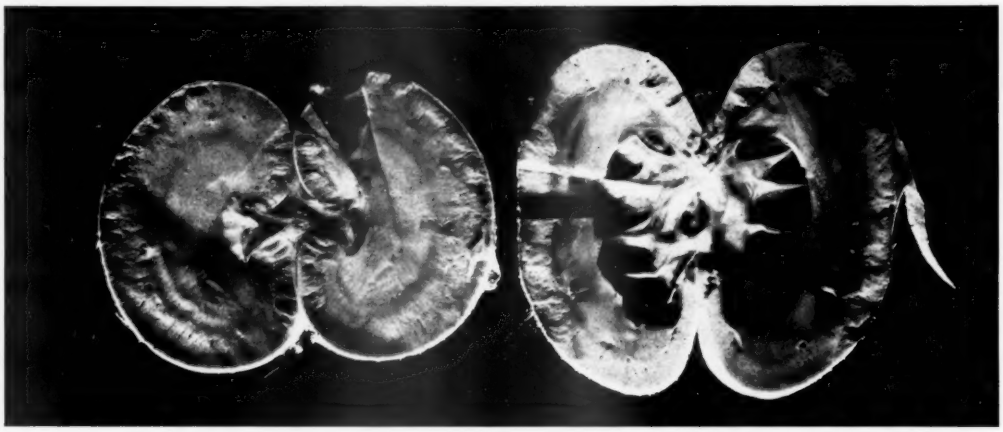

Fig. 1. Dog XXVI. Complete obstruction of the ureter. Duration 5 days. Median section of hydronephrotic kidney with the opposite kidney as control.

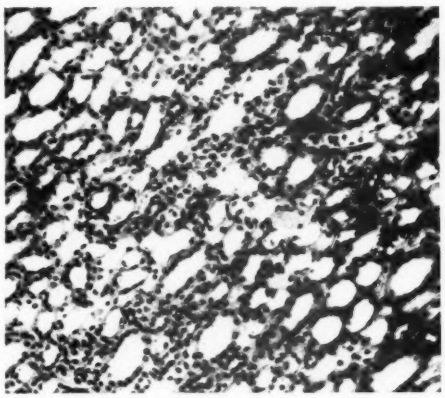

Fig. 2. Dog XXVI. Complete obstruction of the ureter. Duration 5 days. Photo-micrograph of a section of hydronephrotic kidney. Magnification 120 diameters.

suture, and the skin edges approximated by interrupted silk-worm gut sutures. No dressing was applied to the wound except occasionally a fresh application of tincture of iodine. The dogs were autopsied after intervals varying from one day to seven months, and both kidneys removed and examined. Sections were fixed in formalin and imbedded in celloidion or paraffin. Different stains were used, the most satisfactory being eosin and Ehrlich hematoxylin or Weigert's iron hematoxylin.

### HYDRONEPHROSIS PRODUCED BY COMPLETE OBSTRUCTION OF THE URETER

It is generally stated, especially by English and American authorities, that a sudden, complete obstruction of the ureter produces but little or no dilatation of the pelvis, but an atrophy of the kidney, while an incomplete

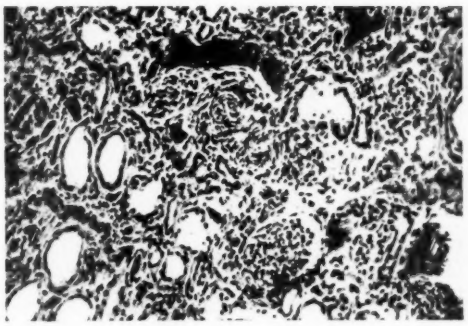

Fig. 4. Dog VIII. Complete obstruction of the ureter. Duration 33 days. Photo-micrograph of a section of hydronephrotic kidney. Magnification 120 diameters.

or intermittent obstruction produces a hydronephrosis of great degree. The explanation given for this is that when a sudden and complete obstruction develops in the ureter, the pressure of the retained urine is sufficient to arrest further secretion. Such statements are made in Watson and Cunningham's Genito-Urinary Diseases, Keyes' Genito-Urinary Diseases, Keen's Surgery, Rose and Carless' Surgery, Johnson's Surgical Diagnosis, the American Text-book of Pathology, and Pilcher's Practical Cystoscopy. These statements are apparently based upon experiments performed by Guyon (2), Cohnheim (3), and Hildebrand and Haga (4).

Guyon, by experimenting upon dogs, found

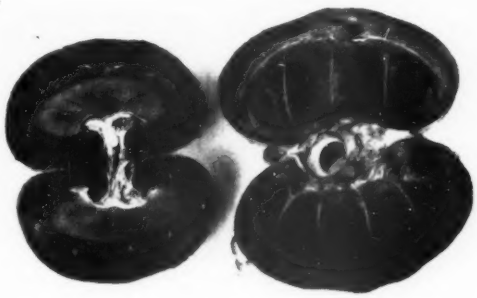

Fig. 3. Dog VIII. Complete obstruction of the ureter. Duration 33 days. Median section of hydronephrotic kidney with opposite kidney as control.

Fig. 5. Dog XXXII. Complete obstruction of the ureter. Duration 83 days. Normal and hydronephrotic kidney.

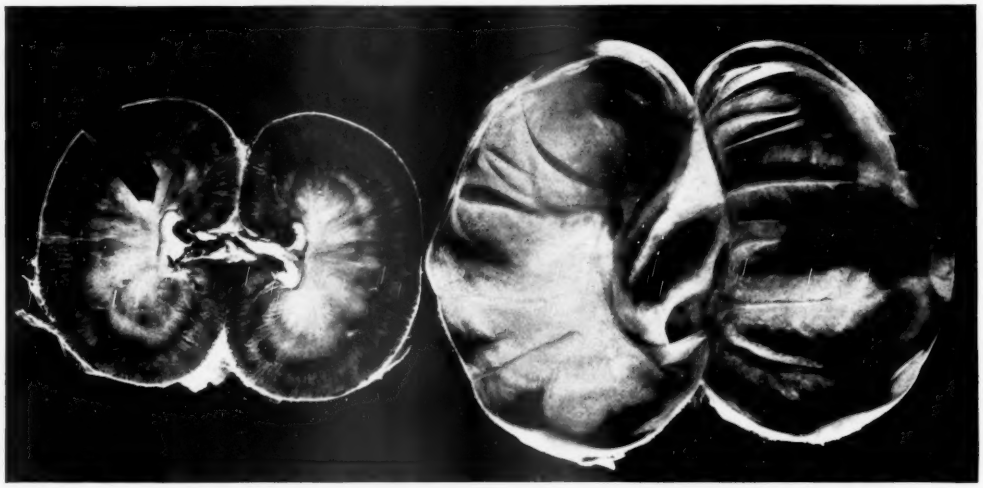

Fig. 6. Dog XXXII. Complete obstruction of the ureter. Duration 83 days. Median section of normal and hydronephrotic kidneys.

that partial obstruction gave rise to hydronephrosis, while a complete obstruction a followed by renal atrophy, after a slight temporary distention.

Hildebrand and Haga performed a series of about fifteen experiments upon dogs, in which they kinked the ureter, twisted the ureter, and produced a floating kidney. They concluded that hydronephrosis resulted from kinking the ureter, but not from a floating kidney, nor from twisting of the ureter.

Cohnheim states that complete obstruction of one ureter in animals leads to only a slight hydronephrosis, while an incomplete ligation results in extensive hydronephrosis.

Lindemann (5) operated upon six dogs,

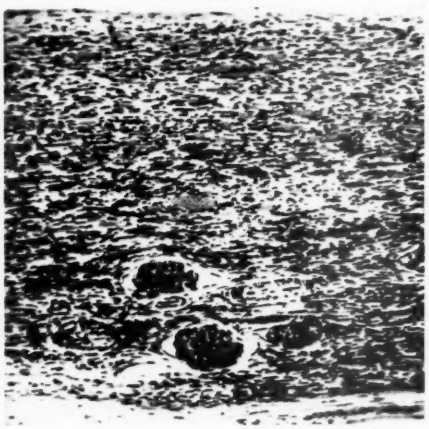

Fig. 7. Dog XXXII. Complete obstruction of the ureter. Duration 83 days. Photo-micrograph of a section through the entire thickness of the wall of the hydronephrotic kidney. Magnification 95 diameters.

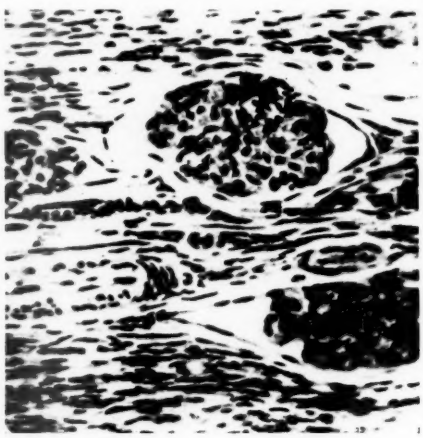

Fig. 8. Dog XXXII. Complete obstruction of the ureter. Duration 83 days. Represents a portion of Fig. 7 under a higher magnification. Photo-micrograph of hydronephrotic kidney. Magnification 250 diameters.

Fig. 9. Dog V. Complete obstruction of the ureter. Duration 33 days. Normal and hydronephrotic kidney.

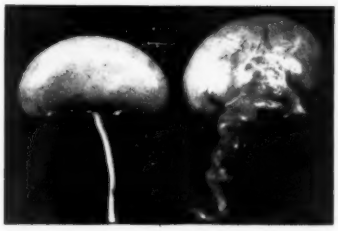

Fig. 10. Dog XXI. Incomplete obstruction of the ureter. Duration 40 days. Normal and hydronephrotic kidneys. For purpose of comparison Fig. 10 has been reduced so as to make the normal kidney of the same size as that in Fig. 9.

producing a complete ligation of the ureter. Two showed hydronephrosis of considerable degree, while in three atrophy resulted. In the remaining dog, the kidney was slightly enlarged, the renal pelvis slightly dilated, but fluid absent. He also performed similar operations upon four rabbits, and in each a hydronephrosis resulted.

Edes (6) states, however, that the amount of urine passed against a certain degree of back pressure instead of being diminished is increased. The back pressure, when not too great, seems to act as a stimulant to the secreting structure. If, however, it gets beyond this point, the secretion obeys ordinary physics and takes place more slowly. The amount of back pressure in the kidneys required to stop the secretion is estimated at about one and six-tenths inches of mercury, while less than half an inch will greatly impair it.

A few clinical cases have been reported in which atrophy of the kidney occurred following complete osbtruction of the ureter. Auscher (7) reports such a case in which the kidney was atrophied to the size of a bean. Tangl (8) reports a case of atrophy of the kidney due to a stricture of the ureter, but does not state whether the stricture was complete or incomplete.

Von Bergmann (9) does not accept the common theory of English and American authorities, but states that a sudden complete osbtruction of the ureter causes a great increase in the renal pelvis, forming a large cyst with a thin shell of cortex. This is supported by experiments of Pearce, (10) Amos (11), Nefedieff (12), Bertenson (13), Bradford (14) Albarran and Bernard (15), Bainbridge (16), and Sollman, Williams and Briggs (17).

Pearce completely ligated the ureter in five rabbits, and with the exception of one animal which developed a pyelonephritis, all showed hydronephrosis varying in degree according to the length of time which had elapsed since the operation. He also tied one ureter in a rat and produced a hydronephrosis.

Amos ligated one ureter in each of six guinea-pigs, and in ten rabbits, and with the exception of two cases, hydronephrosis of varying degrees resulted. In two cases was found a pyelonephrosis.

Bainbridge experimented upon cats by completely ligating one ureter, and produced hydronephrosis in every case.

Nefedieff ligated one ureter of three dogs, for the purpose of studying nephro-toxins, and produced hydronephrosis in each.

Bradford operated on dogs by ligating and dividing the ureter close to the bladder, and produced hydronephrosis in every case.

Sollman, Williams and Briggs tied the ureter in four dogs, to determine if it would be possible to re-establish function of the kidney after temporary ligation of the ureter, and found hydronephrosis in each case.

Bainbridge experimented upon cats by ligating the ureter in two places close to the bladder, and then cut out a portion between the ligatures. His experiments resulted in hydronephrosis.

Fig. 11. Dog XI. Incomplete obstruction of the ureter. Duration 163 days. Atrophied kidney with the opposite kidney as control.

Bertenson carried out various operations on the kidney, with the effect of producing hypertrophy, degeneration, or inflammation of opposite kidney, and concluded that hydronephrosis developed after complete obstruction of the ureter.

Albarran and Bernard tied the ureters in animals for purpose of studying renal cytotoxins, and produced hydronephrosis in every case.

A few clinical cases of hydronephrosis produced by complete obstruction of the ureter have been reported by Bottomley (18), Boström, (19), Heller (20), Welz (21), Billard (22), Thurman (23), Allen and Parker (24), Dowd (25) and Cumston (26).

Below are given the changes, both macroscopic and microscopic, in thirty cases of complete obstruction of the ureter, the length of time varying from five days to one hundred and ninety-eight days. For comparison, the kidneys of the opposite side are described in each case. The control kidneys show engorgement of the vessels in the capsule and in the parenchyma, and are probably larger than normal, due to compensatory hypertrophy. The microscopic changes in the control kidneys are not so great that the kidneys cannot function. The epithelium of the tubules is usually swollen, but the nuclei remain healthy. The glomeruli and their capsules usually show no changes. The detailed protocols are given in only six cases chosen as representative of the series in which the duration of the obstruction was respectively 5, 14, 21, 33, 83, and 198 days. To each of these records is appended the number of experiments in which the obstruction was of approximately the same duration and any differences from the typical record which were found in these other experiments.

1. *Experiments in which the duration of the obstruction was about one week.*

Dog XXVI. Operated November 11, 1910. Autopsy November 16, 1910, 5 days after operation. Double ligation of right ureter. Weight of kidneys not taken. The right kidney is slightly larger than the left. The surface is mottled and the capsular vessels are greatly engorged. It is very tense and fluctuating, resembling a cyst with a very thick wall. The capsule strips easily. The pelvis and ureter are distended and transparent, and the obstruction is complete.

On section (Fig. 1), a clear, straw colored fluid escapes, and the kidney is found to be composed of a slightly atrophied cortex and a small portion of medulla lining a small cystic cavity. The calyces appear as sickle-shaped connective tissue septa extending from the cortex to the pelvis and separating the pyramids from each other. The markings of the kidney are distinct. Reddish areas are scattered throughout both medulla and cortex. The length of the cystic cavity is 3.2 cm., while the width is 2.0 cm. The length of the kidney from pole to pole is 5.7 cm., while the width is 3.4 cm. The width of the medulla is 0.7 cm., and the width of cortex is 0.8 cm. The length of the left kidney from pole to pole is 4.8 cm., while the width is 3.3 cm.; and the width of the medulla is 1.3 cm., and the cortex 0.9 cm.

*Microscopic appearance* (Fig. 2). The entire section of the right kidney presents a honey-combed

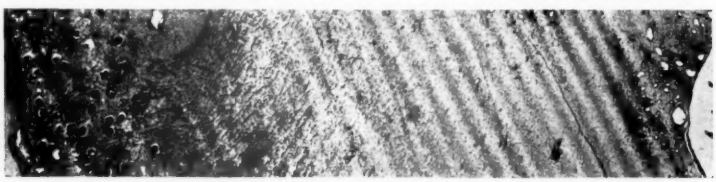

Fig. 12. Dog XI. Incomplete obstruction of the ureter. Duration 163 days. Photo-micrograph of a section of the atrophic kidney.

appearance. The changes in the collecting tubules vary with the area. Near the apices of the medullary pyramids, there is a large amount of connective tissue, the tubules being oval and greatly compressed, the long axis being parallel to the kidney cortex. The epithelium is greatly flattened, the nuclei deeply stained and the lumen partially or entirely obliterated. In another zone, just above the one described, the lumen of the tubules is more dilated, but slightly oval in outline and the epithelium flattened. In the zone above this, where the connective tissue is less in amount, the tubules show a greater degree of dilatation and have a circular outline. Near the cortex the tubules still retain their circular outline, but the dilatation is less marked.

The convoluted tubules are affected to a less degree than the collecting tubules. The dilatation and the flattening of the epithelium is present but less marked. The epithelium throughout the section shows granular changes in some areas, but the nuclei are deeply stained and apparently in good condition.

The glomeruli are normal except a slight dilatation of the capsular space and a slight engorgement of the capillaries.

The capsule of the kidney is apparently normal.

Seven other experiments were performed in which the duration of the obstruction varied from 5 to 8 days and in which the obstruction was found to be complete at autopsy. A histologic examination was made in every case. In all of these, changes occurred along the same lines as in the preceding experiment, a hydronephrosis developing in every case — the cavity varying from 2.5 to 4.1 cm. in length and from 1.6 to 2 cm. in width. Below is given the number of each experiment with any significant variations which occurred.

Dog I. Duration of obstruction 7 days. Changes same as in Dog XXVI.

Dog VI. Duration of obstruction 8 days. There were, in addition to the above described changes, small hæmorrhages in the parenchyma.

Dog VII. Duration 8 days; also the same, except for a few small hæmorrhages.

Dog XVIII. Duration 8 days; also showed a few hæmorrhages into the parenchyma; otherwise the same.

Dog XXVII. Duration 5 days, died of glanders. There was, in addition to the hydronephrosis, a diffuse nephritis.

Dog XLIV. Duration 7 days. A silk sack was sewed around the kidney. The wound became infected and a dense scar was formed upon the surface of the kidney — but the typical changes characteristic of a developing hydronephrosis occurred — more will be said about this experiment in connection with experiment XXXV.

Dog XVI. Duration 5 days. In this case the distention occurred chiefly in the ureter and pelvis. The normal and pathologic kidneys were of the same size but the interior of the latter was hollowed out to form a small cavity 2.5 cm. x 2 cm. in dimensions.

2. *Experiment in which the duration of the obstruction was two weeks.*

Dog II. Operated January 31, 1910. Autopsy February 14, 1910, fourteen days following the operation. Single ligation of left ureter. Weight of left kidney 53 grams, and of the control kidney 34 grams. The distension of the left kidney, pelvis and ureter has progressed somewhat over the average in the preceding experiments, but is not quite so great as in Dog XVIII in which the obstruction was only of 8 days duration.

On section a large amount of clear, straw-colored fluid escapes, and the flattening of the pyramids has progressed. The calyces resemble connective tissue strands, extending from the lower part of pelvis into the medulla. The color is normal except from engorgement of the vessels. The cavity measures 3.6 x 2.2 cm. The medulla is 1 cm. and the cortex 0.5 cm. in width, while in the control kidney the medulla is 1.5 cm. and the cortex 1 cm. in width. The length is 7 cm. and the width 3.5 cm., while that of the control kidney is 6.5 cm. and 3 cm. respectively.

*Microscopic changes.* These are much more advanced than those seen in any of the preceding kidneys. Toward the apices of the pyramids, the the tubules appear as masses of round nuclei with no lumen, due to mashing together of the tubules from the retained fluid in the cystic cavity. The lumina of the remaining straight tubules are widely dilated, the epithelial cells are flattened, and the nuclei are elongated, due to increased backward pressure of fluid in the tubules. The cytoplasm is apparently normal.

The convoluted tubules show important changes. The lumina are enormously dilated, being as large in some places as a normal glomerulus. The epithelial cells are flattened and elongated, and the cytoplasm shows no striations. The nuclei are flattened, deeply stained, and widely separated.

The glomeruli show but slight changes. The capsular spaces are slightly dilated, and the vessels are engorged. The interstitial tissue, and the kidney capsule are not changed.

There were no other experiments in which the duration of the obstruction was approximately 14 days.

3. *Experiments in which the duration of the obstruction was from three to four weeks.*

Dog III. Operated January 31, 1910. Autopsy February 21, 1910, three weeks following operation. Double ligation of left ureter. Weight of left kidney

81 grams, and of control kidney 35 grams. The kidney is more than twice as large as the control of the opposite side, is very tense and fluctuating, and the capsular vessels are greatly distended. The pelvis and ureter above the ligatures are transparent and much more distended than those of previous experiments. On section a large amount of clear straw colored fluid escapes, The cystic cavity is larger than those in kidneys with obstruction of shorter duration, and the papillæ are almost obliterated, showing a further progression of destruction in the parenchyma. The medulla is apparently one-half the width of that in the control experiment. The cavity measures 5.2 x 2.7 cm. The respective widths of the medulla and cortex are 0.9 cm. and 0.4 cm., while those of the normal kidney are 1.4 cm. and .6 cm. The length of the kidney from pole to pole is 7.3 cm. while the length of the control is 6 cm.

*Microscopic changes.* Toward the apices of the former papillæ the straight tubules appear as masses of cells with oval or elongated nuclei and without any lumen. A little more towards the cortex, the lumina are distended and the epithelial cells are flattened, and the nuclei are elongated and stained deep blue. In some areas the cell wall is broken, the cytoplasm disintegrated and the nuclei found in the lumina of the tubules.

The glomeruli are compressed and are more numerous in each field. The capsular spaces in some areas are greatly distended. The blood vessels are slightly engorged, but no hæmorrhages are present. A few patches of round cell infiltration are present in the kidney cortex. The renal capsule is thickened.

With Dog III may be compared Dog IV, duration of obstruction 28 days. The same progressive hydronephrotic changes were noted and in addition an acute diffuse nephritis. Also except near the glomeruli the convoluted tubules were collapsed instead of dilated and appear as masses of cells with deep staining round or oval nuclei. Many hæmorrhagic areas are present and there is marked connective tissue proliferation throughout the section.

The changes in Dog XXXIV, duration of obstruction 29 days, agree closely with those of Dog III.

Dog XLV, duration of obstruction 25 days, died from general peritonitis, due to rupture of the distended kidney. On removal the left kidney is found to be a large collapsed cyst, an opening being on the lateral border. The wall is very thin, and the tissue red and soft, probably due to degenerative changes. The obstruction of the ureter is complete.

*Microscopic changes.* Some of the tubules near the kidney pelvis are compressed due to pressure from the dilatation of others. Practically all of the convoluted, and a great number of the straight tubules are widely dilated. The glomeruli are shrunken and atrophied and the capsular spaces are dilated. There are a few areas of round cell infiltration. The kidney capsule is thickened.

4. *Experiments in which the duration of the obstruction was from five to seven weeks.*

Dog V. Operated February 1, 1910. Autopsy March 6, 1910, thirty-three days after operation, double ligation of left ureter. Weight of left kidney 126 grams and of control kidney 48 grams. The left kidney is about three times larger than the right and is very tense and fluctuating (Fig. 9). Lobulations between the attachments of the calyces to the cortex are quite distinct and the capsular vessels are greatly engorged.

On section the kidney is found to be a large cyst with the thin cortex forming the wall, and a large amount of clear fluid filling the cavity. The calyces appear as thin sickle-shaped bands of connective tissue extending from the pelvis into the thin cortex. The cavity measures 6.5 cm. in length and 4.3 cm. in width, and the cortex .3 cm. and .7 cm. respectively at the thinnest and thickest points. The length of the kidney is 8.2 cm. and the width 4.5 cm. while the respective width of the control kidney is 6 cm. and 3.2 cm.

*Microscopic changes.* The section through the entire thickness of the kidney substance is very narrow. The straight tubules are absent or very much compressed appearing either as a mass of deep staining elongated nuclei placed in a matrix of connective tissue, or as small tubules with compressed lumina, the long diameters of which are parallel to the kidney capsule. The convoluted tubules present a honey-combed appearance. Many are so compressed that the lumina are entirely obliterated while in others the lumina are filled with debris, nuclei, casts, and blood cells. The epithelium is flat and the nuclei oblongated, while the cytoplasm has lost its striated appearance. The glomeruli are crowded together, much smaller than normal, and apparently more numerous in each field. They are so compressed that the long diameter is parallel to the kidney capsule. The capsular spaces are widely dilated and the capsular epithelium compressed and flattened. The interstitial tissue shows marked proliferation throughout the section. The blood vessels are engorged throughout and interstitial hæmorrhages are present in some areas. The capsule of the kidney is sclerotic.

With Dog V is to be compared Dog VIII, duration of obstruction also thirty-three days (Fig. 3). The distention of the kidney has not progressed quite so far and the convoluted tubules are still widely dilated and there is, as in Dog V, a diffuse nephritis. The microscopic changes are given in detail for comparison with the microphotograph (Fig. 4).

*Microscopic changes:* Near the pelvis the straight tubules are so compressed that the lumina are obliterated. Near the cortical zone they are distended, but so compressed that their long axes are parallel to the kidney capsule. The convoluted tubules are greatly dilated and the epithelial cells are compressed and flattened. The cytoplasm in most areas has lost its striations. The nuclei are flattened, but stained deep blue. The glomeruli are much smaller than normal and hence are more numerous in each field. The capsular spaces are usually dilated and contain debris. The interstitial tissue is increased in amount and round cell infiltration is seen in some areas. All the vessels are greatly engorged, and hæmorrhagic areas are numerous, especially in the cortical zone. The capsule is thickened.

In Dog XLIII, duration of the obstruction 49 days, the distention of the kidney has progressed farther than in Dog V or VIII, but the microscopic changes closely resemble those in Dog VIII. The chief difference of importance is the appearance of sclerotic blood vessels in this specimen.

5. *Experiments in which the duration of the obstruction was from eight to twelve weeks.*

Dog XXXII. Operated December 2, 1910. Autopsy February 23, 1911, eighty-three days following operation. Double ligation of left ureter. Weight of left kidney 115 grams and of the control 27 grams. The left kidney (Fig. 5) is more than three times larger than the control, and is apparently a thin-shelled monolocular cyst, filled with a clear fluid, so that on holding it to the light one can see through the specimen. The surface is smooth, but the attachments of the calyces can be seen through the thin wall. The pelvis and ureter above the ligature are greatly distended with clear fluid, and the obstruction is complete.

On section (Fig. 6) a large amount of clear fluid escapes, and the kidney is a cyst, with a wall as thin as paper. The parenchymatous tissue is apparently destroyed except for a strip from 1 to 2 cm. in width, extending from pole to pole along the border of the kidney opposite the hilus. This strip is of extreme thinness and sends finger-like projections outward along the wall of the cyst, extending toward the ureter between the attachments of the calyces. The length of the cavity is 7.0 cm. and the width 4.8 cm. The length of the control is 5.1 cm. while the width is 3.0 cm.

*Microscopic appearance.* Under low power (Fig. 7) the section resembles a narrow ribbon of connective tissue with a few small oval glomeruli on one side. Under high power (Fig. 8) the conducting tubules could not be distinguished from connective tissue bundles were it not for a small amount of albuminous precipitate scattered here and there, which on close observation is recognized as being in the lumina of the tubules. The convoluted tubules are much atrophied, being recognizable only in a few places.

The glomeruli are much atrophied and so compressed that they are oval in shape, the long axis being parallel to the kidney capsule. The glomerular spaces are widened, especially at the oval extremities of the glomeruli, where they are pointed and resemble handles on the glomeruli. The blood vessels show sclerosis. The kidney capsule is thickened.

These changes are very characteristic for this stage in the development of a hydronephrosis. There were three other specimens of this stage: Dog XXXVII, duration of obstruction 53 days, weight of the hydronephrotic kidney eight times that of the normal; Dog X, duration of the obstruction sixty-eight days, weight of hydronephrotic kidney 6.7 times that of the control; and Dog XXX, duration of obstruction eighty-five days, weight of hydronephrotic kidney three times that of the control. In each of these the histologic changes were almost identical with those in Dog XXXII. In Dog XXV, 72 days following the operation, there is a pronounced, diffuse nephritis and hydronephrosis has not advanced as far as in other kidneys with an obstruction of the same duration. The hydronephrotic kidney is, however, 2.5 times the size of the control and possesses a cystic cavity measuring 6.5 x 4.4.

6. *Experiments in which the duration of the obstruction was from sixteen to twenty-eight weeks.*

Dog IX. Operated March 1, 1910. Autopsy September 15, 1910, one hundred ninety-eight days following operation. Double ligation of right ureter. Weights and measurements of kidneys not taken. The right kidney is about five times larger than the control, is very tense and fluctuating, and resembles a large thin shell monolocular cyst. The surface is marked off into lobules with depressions at the sites of attachments of the calyces. The pelvis and ureter above the ligatures are distended.

On section a large amount of clear fluid escapes, leaving a cystic cavity. The wall is composed of cortex.

*Microscopic appearance.* Under low power the section resembles a narrow ribbon of connective tissue with a few small oval nuclei on one side. The straight tubules are distinguished from connective tissue bundles by a small amount of albuminous precipitate, which on close observation is found to lie in the lumina of the tubules. The epithelium is compressed, flattened, and elongated, and the nuclei stain deep blue. The convoluted tubules are

atrophied and recognized as such only in a few areas. The glomeruli are much atrophied and compressed, and are oval in shape with the long axes parallel to the kidney capsule. The capsular spaces are dilated, especially at the extremities of the oval glomeruli. The blood vessels are markedly sclerotic, and the kidney capsule is thickened.

The kidney therefore resembles very closely the 84 day kidney just described, and since three other kidneys with an obstruction of similar duration showed a hydronephrosis of the same stage, we may assume that a hydronephrosis due to complete obstruction advances very slowly, if at all, after the first three months. The duration of the obstruction in the three kidneys just mentioned was as follows: Dog XV, 145 days; Dog XIV, 163 days; Dog XVII, 170 days. The gross and microscopic changes seen in these kidneys agree closely with those described for Dog IX and Dog XXXII. In none of the kidneys was there evidence that an atrophy had developed.

The specimen removed from Dog XXIII resembles in many points that from Dog XVI, in which, it will be remembered, the distention occurred chiefly in the pelvis and in the ureter above the ligature. The duration of obstruction in Dog XXIII was 112 days. The two kidneys were of about the same size but the pathologic one was hollowed out to form a thin-walled cyst, while the pelvis and ureter above the constriction were enormously dilated. The histologic changes are identical with those found in all the other cases of prolonged obstruction.

In the above experiments, in which thirty complete ligations of the ureter were performed, a typical hydronephrosis resulted in every case, the degree depending upon the duration of the obstruction. These represent all stages of hydronephrosis, from a slight dilatation of the ureter to a large monolocular, thin-shelled cyst filled with clear fluid. It is evident that the degree of dilatation depends upon the duration of the obstruction. The dilatation gradually increases until a thin-shelled monolocular cyst is formed, which in medium-sized dogs requires from four to six weeks. The kidney parenchyma is gradually compressed and the calyces flattened so as to give a typical sickle-shaped appearance. The changes produced are due to two causes, as formerly stated by Griffiths (27). The first is direct pressure of the accumulating fluid on the kidney tubules, and the second the impoverished nutrition of the parenchyma from the compressing and stretching of the renal vessels as they enter the renal pelvis, and from the sclerosis of their walls. The changes produced by direct pressure of the accumulating fluid take place in a definite order. First, the fluid collects in the renal pelvis and then backs up into the straight tubules. These are usually dilated, especially in early stages, but later, as the pressure of the accumulating fluid increases, both in the renal pelvis and in the tubules, some are compressed so that the lumen is practically obliterated. This is especially noted in the tubules subjacent to the renal pelvis. The next change noted is the dilatation of the convoluted tubules with a flattening of the epithelium due to a gradual back flow of the accumulating fluid. The glomeruli are last to suffer, and the changes occurring in these consist in dilatation of the capsular spaces and shrinking of the capillary tufts. The glomeruli in late stages are atrophied to great degree, and so compressed together, that they are more numerous in each microscopic field. In specimen with thin walls, the glomeruli are so compressed that they are elongated, the long axis being parallel to the kidney capsule, and the capsular spaces widened at each extremity so as to resemble handles to the glomeruli. The epithelium loses its striated appearance early and becomes granular, due probably to both pressure, and poor nutrition from vascular changes. The nuclei stain deep blue and are apparently healthy. In early stages the vessels are usually engorged, but later sclerosis of their walls is marked. The interstitial tissue shows varying degrees of infiltration according to the duration of the process, at first being patched with areas of small round cell infiltration, to be replaced later by more sclerotic tissue. The kidney capsule in early stages is not changed except for an engorgement of its vessels, but later it is usually thickened. The fluid in every case was clear, showing no infection either ascending or descending, which was verified upon micro-

scopic examination of the kidney tissue. No chemical examination of the fluid was made.

Griffiths (27) states that the highly specialized cells of the renal tubules gradually diminish in size and ultimately disappear entirely, being replaced by connective tissue. But in the most advanced stages of the above experiments, tubular epithelium was always demonstrable, and capable of secretion as will be shown later.

INCOMPLETE OBSTRUCTION OF THE URETER

Below are given the results in eleven cases of incomplete obstruction of the ureter, produced by placing a rubber band around the ureter, as described above. After periods varying from one day to 163 days, the dogs were autopsied, the kidneys weighed, measured, and the pressure required to expel the fluid through the obstruction taken by a manometer. The first three cases given below show most clearly the results of an incomplete obstruction of the ureter.

Dog XX. Operated April 13,1910. Autopsy thirty-eight days following operation. Incomplete ligation of left ureter. The left kidney is slightly larger than the control. The surface is smooth and the capsular vessels are engorged. It is tense and fluctuating. The pelvis and ureter above the rubber band are slightly distended, and the obstruction is incomplete. The pressure required to expel the fluid through the obstruction is 20 mm. Hg.

On section a clear fluid escapes, leaving a small cystic cavity. The pyramids are slightly flattened, and the calyces have the characteristic sickle-shaped appearance. The length of the kidney from pole to pole is 5.7 cm., while the width is 3.5 cm. The respective widths of the cortex and medulla are 0.6 cm. and 1.0 cm. The length of the cavity is 2.8 cm., and the width is 1.2 cm. The length of the control kidney is 5.4 cm., and the width is 2.9 cm.

*Microscopic appearance.* The section may be described as consisting of three zones. The tubules of the inner zone are slightly compressed so that they are oval in shape, with the long axis parallel to the kidney capsule. The lumen of the tubules is not obliterated, and the epithelial cells are not greatly flattened. The tubules are widely separated from one another, and the connective tissue is increased.

In the middle zone the tubules are circular in shape, and greatly dilated. The tubules are widely separated from each other by connective tissue.

In the outer zone the tubules are slightly distended, but retain their normal contour. The interstitial tissue is less in amount than in other parts of the section. The glomeruli are but little changed except a slight distension of the capsular spaces.

The epithelium throughout the section show granular changes, but the nuclei are deeply stained. The blood vessels are engorged. The kidney capsule is thickened.

Dog XXII. Operated April 21, 1910. Autopsy May 28, 1910, thirty-seven days following operation. Incomplete obstruction of right ureter. Weight of right kidney 113 grams, and of left kidney 35 grams. The right kidney is more than three times as large as the left. The surface is smooth, and the capsular vessels are slightly engorged. It is fluctuating, especially near the pelvis. The pelvis and ureter above the rubber band are transparent and distended. The pressure required to force urine drop by drop through the obstruction is 45 mm. Hg.

On section a large amount of clear fluid escapes, leaving a large monolocular cystic cavity. A small portion of the medulla, and a larger amount of the cortex is present, especially at each pole of the specimen, where the atrophy is less pronounced. The calyces have the sickle-shaped appearance, as in other specimen. The length of the right kidney from pole to pole is 7.7 cm., and the width is 4.2 cm. The average width of the cortex is 0.6 cm., while that of medulla is 0.3 cm. The length of the cavity is 5.9 cm., and the width is 3.7 cm. The length of the control is 5.6 cm., while the width is 3.2 cm.

*Microscopic appearance.* This section is very much like that described under Dog No. XX and may be described as having three zones. The changes are, however, somewhat more advanced. The tubules in the inner zone are either so flattened that they are obliterated or their lumina are very narrow and elongated in the direction of the long axis of the kidney. The nuclei are long, narrow, and deeply stained. The interstitial connective tissue is probably increased. In the middle zone the tubules are dilated and circular in outline. The epithelium is flattened and the nuclei are deeply stained. The outer zone is much like the middle, with the exception that there are a few areas in which the tubular epithelium is more cuboidal. The glomeruli are but little affected, except for a slight flattening of the epithelium and distention of the capsular space. The cytoplasm of all the epithelial cells is granular. The arteries show a mild degree of sclerosis. The kidney capsule is slightly thickened.

Intermediate in position between these two kidneys is that of Dog XXI, incomplete ligation of the left ureter of 40 days duration. The pressure required to expel urine through the obstruction was 27 mm. Hg. By comparing the account of the kidneys from Dogs XX, XXI and XXII with that of those from Dogs V and VIII it will be seen that a complete obstruction produces a hydronephrosis more rapidly than an incomplete (Figs. 9 and 10); and it will be seen on comparing XX,

XXI and XXII with each other that the rapidity of the change depends upon the degree of the obstruction — an obstruction which it requires 45 mm. Hg. to overcome, acting almost like a complete obstruction.

The remaining experiments to be reported do not add much to the information gathered from the three preceding experiments regarding the effect of an incomplete as compared to that of a complete obstruction, but some of them have a special interest of their own and the others will only be enumerated.

Dog XIX, duration of incomplete obstruction 1 day, and Dog XXXIX, duration of incomplete obstruction (becoming complete through the blocking of the lumen by a blood clot) 2 days, both show a beginning hydronephrosis and acute diffuse nephritis.

Dog XLII, duration of incomplete obstruction 6 days, shows a hydronephrosis of less marked degree than would have resulted from a complete obstruction of the same duration; but in this case the result is complicated by the fact that the animal died of an acute infective cholecystitis and angiocholitis. The kidney showed, besides beginning hydronephrosis, an acute parenchymatous nephritis. The next kidney is of interest as the only instance of pyonephrosis in this series of 41 cases.

Dog XL. Operated February 20, 1911. Autopsy May 12, 1911, eighty-one days following operation. Incomplete ligation of the left ureter. An external uretal fistula in the scar of the incision is present, through which urine escaped. On removal, the left kidney is found to be a tense monolocular cyst, with a rough lobulated surface. The pelvis and ureter above the rubber band are distended. The pressure required to expel urine through the fistulous opening is 50 mm. Hg. The weight of the kidney is 85 grams, and the weight of the control is 20 grams.

On section of the left kidney a large amount of pus escaped, leaving a cystic cavity, with a thin wall composed of cortex. The length of the cavity is 4.7 cm., while the width is 3.4 cm. The length of the control kidney is 4.9 cm., and the width is 2.8 cm.

*Microscopic appearance.* The section shows the changes of an acute diffuse nephritis, and a pyelitis. Both the straight and convoluted tubules are dilated, and the epithelium is flattened. The glomeruli are slightly compressed. The medulla is filled with polymorphonuclear leucocytes. The connective tissue is increased, and areas of round cell infiltration are present. The blood vessels are engorged. The kidney capsule is thickened.

Dog XXXVII. Operated January 20, 1911. Autopsy May 26, 1911, 126 days following operation. Incomplete obstruction of the left ureter. Apparently the kidney is no larger than the control, but the ureter is greatly distended. The obstruction is incomplete. The pressure required to expel the fluid through the obstruction is 40 mm. Hg. The weight of the left kidney is 36 grams, while that of the control is 33 grams.

On section a small cystic cavity is present measuring 2.7 cm. in length, and 1.5 cm. in width. The cortex apparently contains much connective tissue. The calyces are rounded instead of being sickle-shape.

*Microscopic appearance.* The section shows all the changes of an acute diffuse nephritis. Most of the tubules, both straight and convoluted, are compressed. The epithelium is granular, and disintegrated. The tubules contain debris, and casts. The glomeruli are atrophied, compressed, and more numerous in each field, numbering seventy-five to one hundred (low power). The capsular spaces are greatly dilated, and filled with detritus. The interstitial connective tissue is greatly increased, especially in the cortical area. Round cell infiltration is present over the entire section. The vessels are slightly engorged. This kidney resembles, in many points, those from Dogs XVI and XXIII and makes in all three cases in which the chief dilatation occurred in the pelvis and ureter above the obstruction, and does not indicate an atrophy of the kidney such as occurred in the next kidney.

Dog XI. Operated March 8, 1910. Autopsy August 18, 1910, 163 days following operation. Right ureter ligated with silk-worm gut, about four inches below the pelvis of the kidney. At autopsy the obstruction was found to be incomplete. The kidney is normal in shape but very small, being about the size of a large butter bean (Fig. 11). The surface is smooth, and the color normal, and the consistency firm. The pelvis and ureter above the ligature are not distended. The obstruction is incomplete, and the urine can be expelled through the ureter with but little pressure.

On section, the medulla and cortex are both found to be atrophied, and the pelvis slightly dilated forming a small cystic cavity. The length of the kidney from pole to pole is 3.8 cm., while the width is 1.9 cm. The length of the cavity is 1.5 cm., and the width is 1.1 cm. The width of the cortex is 0.3 cm., while that of the medulla is 0.5 cm. The length of the control kidney is 5.8 cm., while the width is 3.4 cm.

*Microscopic appearance.* Under low power (Fig. 12) the section is apparently a mass of scar tissue studded in the cortical area with widely dilated tubules having flattened epithelium, and atrophied glomeruli with shrunken capillary tufts resembling mulberries. Under high power the medulla is found to be composed chiefly of stellate connective tissue cells, in which are placed a few flattened kidney tubules. In the cortical area are a few widely dilated tubules, with flattened epithelium. Few vessels are seen. The kidney capsule is thickened. This is the only experiment among the 41 in which an atrophy occurred.

Dog XXVI. Bilateral Hydronephrosis. Operated January 19, 1911. Left ureter exposed and a

rubber band placed around it in such a manner as to form an incomplete obstruction. Secondary operation performed May 12, 1911, 84 days after first operation. The left kidney was exposed through the old incision. The left kidney was distended, and apparently a large monolocular cyst. The pelvis and ureter above the rubber band was distended and the obstruction was incomplete. The ureter below the obstruction was not atrophied. An aspirating needle was introduced into the kidney substance and a clear fluid was withdrawn. The walls of the cyst were about the thickness of paper. The right ureter was exposed by passing the finger behind the aorta from the left side, and a double silkworm gut suture tied around it in such a manner as to produce a complete obstruction. The dog died three days later and an autopsy was performed.

Autopsy Report: The subcutaneous tissue and the abdominal viscera are very edematous. The left kidney is a large, tense fluctuating, monolocular cyst, with a smooth, shiny surface. The obstruction of the ureter is incomplete. The pressure required to expel the fluid through the ureter is 60 mm. Hg.

On section of the left kidney a large amount of clear fluid escapes, leaving a large cystic cavity. The walls are about the thickness of paper. The calyces have the characteristic sickle shape. The length of the cyst is 6.7 cm., and the width is 4.6 cm.

The right kidney is edematous, soft, and slightly cystic. The capsule strips easily. The obstruction is complete.

On section a small amount of clear fluid escapes leaving a small cavity. The appearance of the parenchyma is that of an acute diffuse nephritis. The length of the kidney is 7.0 cm., and the width is 4.6 cm. The length of the cavity is 2.5 cm., while the width is 1.5 cm.

*Microscopic appearance:* Left Kidney. The section shows changes of an acute diffuse nephritis plus those of a marked hydronephrosis. Many of the straight tubules are compressed, while others are dilated. Practically all of the convoluted tubules are dilated. The epithelium is flattened. The glomeruli are atrophied and the capsular spaces are dilated. The blood vessels are engorged, and a few hæmorrhages are scattered over the entire section.

Right Kidney. The changes are those of an acute diffuse nephritis, plus a slight dilatation of the straight tubules.

Dog XXXV. Operated December 20, 1910. Autopsy January 11, 1911, 22 days following operation. Two silkworm gut ligatures placed around the left ureter, and a sack of gutta percha sutured around the kidney so as to shut out the capsular vessels. At autopsy the kidney is surrounded and held fast to the lumbar region by scar tissue. The gutta-percha is still intact. The cortex is apparently of scar tissue and is rough and hard. The shape of the kidney is normal, consistency firm, and the color pale. The pelvis is very much distended, forming a small cyst about the size and shape of a hickory nut. The ureter above the ligature is slightly distended and the obstruction is incomplete. The pressure required to expel fluid through the obstruction is 30 mm. Hg. The weight of the left kidney is 69 grams while that of the right is 67 grams.

On section a small amount of clear fluid escapes, leaving a small cystic cavity in the center. The calyces are white, broad, and extend from the pelvis to the medulla, separating the pyramids. The markings of the kidney are distinct. The capsule is ivory in color and very tough, being almost the consistency of cartilage and is from 1 mm. to 3 mm. in thickness. The length of the kidney from pole to pole is 6.0 cm., while the width is 4.0 cm. The respective widths of the cortex and medulla are 1.0 cm. and 1.1 cm. The length of the cystic cavity is 2.2 cm. while the width is 2.1 cm. The length of the control kidney is 7.0 cm. and the width is 4.3 cm.

*Microscopic appearance.* The most important changes in this section are in the capsule. It is described as having three zones. The first zone, which is the most peripheral, is made up of small, round new connective tissue cells with deep staining nuclei. The second zone is composed of irregular, stellate connective tissue cells with long, sharp branching processes, and numerous clasmatocytes. The inner zone is composed of older connective tissue cells of the spindle-shaped variety. This zone sends projecting processes down into the kidney substance at different areas to form septa. In these septa a few embryonal kidney tubules are seen. A few of the straight tubules are dilated and the cytoplasm is granular. The arteries in the capsule are obliterated.

With this experiment should be compared No. XLIV, already mentioned, under complete obstruction in which the hydronephrosis developed typically although a silk sack had been sewed about the kidney to shut out collateral circulation. In experiment XXV, however, the results are not so clear, as the two kidneys are of practically the same weight and the control kidney is longer and thicker than the hydronephrotic one, indicating perhaps a beginning atrophy.

Lindemann (28) after his six experiments of complete ligation of the one ureter in dogs, in three of which primary atrophy of the kidney followed, while in the remaining three a simple hydronephrosis developed, concluded that whether a primary atrophy of the kidney or a hydronephrosis resulted depended upon the grade of development of compensatory anastomosis through the vessels of the capsule. The intrapelvic pressure following the ligature, he claims, blocks the renal vessels coming in at the hilus, and the further effect of the

ligature depends upon the amount of blood the kidney substance can get through anastomosis between the renal vessels and its capsular vessels. Kidney atrophy means a primary insufficiency of compensation through the blood supply of the capsule. But if the capsular blood supply is good, hydronephrosis will develop.

Senator (29) confirms the theory of Lindemann, and states that the different modes of termination to the kidney after complete obstruction of the ureter depend upon the individual conditions permitting the development of a collateral circulation in the kidney, especially the cortical substance. He states the kidney consists of three distinct vascular zones, the first supplied exclusively by capsular vessels, the second supplied by both the capsular vessels and terminal branches of the renal arteries, the third chiefly supplied by the renal arteries, supplemented by very slight anastomosis with the arteries of the pelvis of the kidney of the ureter.

The kidney capsule and part of the cortex are supplied by the inferior phrenic, capsular, lumbar, and renal arteries. Assuming that hydronephrosis or atrophy of the kidney depends upon these vessels anastomosing with the renal arteries after complete ligation of the ureter, the two above experiments were performed. While the results, so far as they go, speak against the theory of Lindemann, these two experiments are not enough to be conclusive.

Of the eleven experiments of intermittent instruction of the ureter all showed hydronephrosis of varying degree. By comparing the cases of complete and incomplete obstruction it will be seen that in the former hydronephrosis develops more rapidly. It is also evident that the degree of hydronephrosis not only depends upon the length of time of the obstruction and the type of obstruction, whether complete or incomplete, but it also depends upon the degree of the constriction. In experiment XXII of thirty-seven days duration where the pressure required to expel urine through the constriction is 45 mm. Hg., the cavity formed is twice that in the experiment XX of thirty-eight days duration, where the pressure is approximately one-half that of the former. In experiment XI the kidney is atrophied to the size of a butterbean. This is the only one of the entire series in which atrophy occurred, and in this experiment the obstruction of the ureter was incomplete. The microscopic changes in kidneys of incomplete obstruction of the ureter are about the same as those in which complete obstruction is present. The rapidity of dilatation of the tubules depends upon the degree and duration of the obstruction.

## CONCLUSIONS

1. Complete ligation of the ureter produces hydronephrosis, the degree depending upon the duration of the obstruction.

2. The changes occurring in the kidney parenchyma after complete obstruction of the ureter take place in a definite order. First, the straight tubules are dilated, then the convoluted tubules are similarly affected, and last to suffer are the glomeruli. These changes consist of dilitation of the tubules, flattening of the epithelium, granular changes of the epithelial cytoplasm and occasionally breaking of the cell wall. The interstitial tissue is usually increased and in late stages the blood-vessels are sclerotic.

3. Compensatory circulation by anastomosis of the renal vessels with vessels entering the kidney through the capsule probably plays no part in determining whether a primary atrophy or hydronephrosis develops after complete ligation of the ureter.

4. Incomplete obstruction of the ureter produces hydronephrosis.

5. The degree of hydronephrosis following incomplete ligation of the ureter depends upon the duration and upon the pressure required to force urine past the constriction.

6. Complete permanent obstruction produces hydronephrosis more rapidly than an incomplete obstruction of the ureter.

7. The microscopic changes following incomplete obstruction of the ureter are practically the same as those following complete obstruction.

8. Complete ligation of the ureter retards secretion of the kidney but will not completely arrest it.

9. In hydronephrosis of highest degree, the

kidney epithelium is never completely destroyed, but is capable of further secretion.

10. Complete permanent ligation of the ureter does not produce atrophy of the kidney, but this resulted in one case of incomplete obstruction.

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# BISMUTH POISONING

## A Clinical and Pathological Report

By LEO MAYER, M. D., and GEORGE BAEHR, M. D., New York City
(From the First and Second Surgical Services and the Pathological Laboratory, Mt. Sinai Hospital.)

THE opinion is prevalent in the profession that the insoluble salts of bismuth are harmless drugs. It was even questioned at two recent medical meetings in New York whether any authentic case of bismuth poisoning had ever been reported. Yet a review of the literature of the last thirty years will convince the most skeptical that bismuth, even in its insoluble salts, can be profoundly toxic. The extensive surgical use of bismuth as a salve, powder (dermatol), and particularly as a paste (Beck) for injection into sinuses, gives significance to this toxic action. Dr. Beck himself has repeatedly emphasized the danger of bismuth poisoning and has reported three fatal cases that came under his observation. Despite his warning, the danger of toxic results is not yet sufficiently recognized. To emphasize this danger and add some few facts to our knowledge of bismuth poisoning, we purpose, in this paper, a brief review of the literature of bismuth intoxication and the report of three cases, one of them fatal, following the use of Beck's bismuth paste.

### I. HISTORICAL

Though cases of bismuth poisoning, probably due to impurities, were reported as early as 1793 by Pott, the authentic literature begins with Kocher's (29) paper of 1882. Kocher dusted bismuth subnitrate powder over granulating wounds to secure aseptic healing. Although the wounds healed, Kocher condemned

his own method, because in six cases toxic results occurred. These were severe stomatitis, progressing in some instances to ulceration and grangrene, nephritis, and enteritis. One patient died; the autopsy showed black discoloration of the mucosa of the entire large gut. The following year Peterson (45), Riedel (48), and Israel (24) each reported similar toxic results. Possibly because of these case reports Steinfeld and Meyer (41) in 1884 undertook a study of experimental bismuth poisoning. They injected bismuth oxide subcutaneously into frogs, rabbits, cats, and dogs. They produced two types of poisoning: first, an acute, characterized by death in a few hours with convulsions, rapid respiration, and slow pulse; second, a chronic type, characterized by lassitude, stomatitis, salivation, anorexia, vomiting, diarrhœa, tenesmus (dogs), loss of weight and body heat, albuminuria and occasionally tetanic contractions. Postmortem examination showed ulceration and necrosis of the mucous membrane of the large gut. Their explanation of this pathological condition was that the bismuth, circulating in the blood in a soluble form, was precipitated in the large intestine by hydrogen sulphide, and that the bismuth sulphide produced the necrosis by mechanically blocking the smaller blood and lymph-vessels. They proved their theory by giving sufficient bismuth by mouth to absorb all the hydrogen sulphide of the gut, then injecting bismuth intravenously, and in such cases there were no evidences of inflammation of the colon.

In 1886 Dalché (12) reported the first of a long series of intoxications that had followed the application of bismuth salve to burns. Eight days after applying the salve the patient complained of dysphagia, and a bluish black line appeared on the gums and a white false membrane on the palate. Two weeks later the patient developed diarrhœa, vomiting, singultus and albuminuria. The feces and urine contained bismuth; the bismuth used contained no impurities. When the salve was no longer applied, the symptoms gradually disappeared. The following year Dalché published, with Villejean (13), the results of experimental bismuth intoxication. They found that bismuth subnitrate given by mouth to dogs was practically insoluble, and that as much as ten grams a day for a month would not produce toxic symptoms. When injected subcutaneously, however, it formed a soluble albuminate which rapidly produced a chronic bismuth poisoning similar to that described by Steinfeld and Meyer. Chemical analysis of animals thus poisoned showed bismuth in the liver, salivary glands, kidneys, and spleen.

Seven years later (1894), Wilson (62) reported a fatality following the application of bismuth subnitrate to an extensive burn. Characteristic stomatitis developed eight days after the first application; death occurred after sixteen days. In 1896 Cohn (9) published a peculiar case of intoxication resulting from the internal administration of 0.3 grams of the subnitrate four times a day for two and a half days. The symptoms here were lassitude, a metallic taste, a gray line on the gums similar to the lead line, and small ulcerations of the buccal mucosa. This is the single case in the literature in which bismuth subnitrate by mouth produced symptoms of metallic poisoning. It accords with our recent proof that bismuth subnitrate is absorbed even when given by mouth and excreted in the urine (*vide infra*). In the same year Gaucher (21) reported four cases of bismuth stomatitis, and Balli and Baucher (4) four cases, one of them fatal, after the application of bismuth subnitrate to ulcers and burns.

Despite these reports, the application of bismuth to granulating surfaces continued and the list of intoxications grew correspondingly. In 1901 Muhlig (43) reported three cases, Dressman (17) one. The latter cites similar results following the external use of other bismuth preparations: bismuth salicylate, Solger (55); dermatol (bismuth subgallate), Wiener and Glasser (22); and airol (basic bismuth oxyiodide of gallic acid), Aemmer (1). In the last instance a 10% glycerine-olive oil emulsion of airol was injected into a tuberculous sinus. In 1905 Mahne (35) reported a fatal case after the application of ten per cent salve to extensive burns; autopsy showed, as in previous cases, a black discoloration and necrosis of the colon and degeneration of the kidney parenchyma. Martens (36) in 1909

reported two cases; Windrath (63) in 1910, two more, one fatal; Dorn (15) nine cases, five of them fatal; and Rossle (49) in 1911, three fatalities. Dorn's and Rossle's cases followed the application of dermatol (bismuth subgallate) to burns.

In all, *we have been able to collect 42 cases of bismuth intoxication (including Aemmer's), 13 of them fatal, following the application of bismuth salts to granulating surfaces.*

These clinical reports are supported by experimental investigation. In addition to the work of Steinfeld and Meyer, and Dalché and Villejean, already referred to, theses have been published by Dubinsky (18), Feder-Meyer (20), Langhans (30), Mayser (40), Mory (42) and Schmelzer (53), all of whom found characteristic symptoms and pathological changes in animals poisoned with bismuth. Of the theses the most thorough is Schmelzer's. He was the first to attempt the micro-chemical demonstration of bismuth in the tissues of poisoned animals. Incomplete though his work is in this respect, he was able to prove that bismuth granules are present in the gastrointestinal tract of some birds and mammals.[1] Frequently these granules were found within the "wanderzellen" of the intestinal mucosa. His research confirms Steinfeld's results in most respects, but on one point he takes issue: Steinfeld's explanation of the changes in the large gut. Steinfeld assumed these to be due to the formation of bismuth sulphide by the hydrogen sulphide of the gut, but Schmelzer denies that hydrogen sulphide is the essential causative factor, since similar changes are present in the small gut of the goose, whose intestinal tract contains no hydrogen sulphide (Tappeiner, 59).

*The close resemblance of the symptoms and lesions produced experimentally to those found clinically, the constancy of these findings despite the variation in the salt and the chemical purity of the bismuth as established by many authors, leave no doubt that the toxic effects are due to the metal bismuth.*

Strikingly different from these cases of chronic poisoning is a number of cases of acute intoxications following the internal administration of bismuth subnitrate for X-ray purposes. The first was published by Benneke and Hoffman (6) in 1906. A three weeks' infant was given three or four grams of bismuth subnitrate in buttermilk to diagnose a possible pyloric stenosis. Twelve hours later the infant became deeply cyanotic and died within three hours; the blood showed methæmoglobin. About the same time Sailer (52), of Philadelphia, reported four peculiar cases of intoxication following the ingestion of the subnitrate; none was fatal; in all there were marked cyanosis, weakness, dyspnœa, and nausea. The following year Boehme (8*a*) reported a second fatal case, a child one and one-half years old, given a few grams of bismuth subnitrate by mouth and two days later by rectum, died three hours after the rectal injection. The blood showed methæmoglobin, and all the mucous membranes a brownish discoloration. Prior (46) in 1907, told of a two and one-half weeks' infant to whom ten grams of bismuth subnitrate were given in thirty-six hours. The skin became pale greenish gray, the mucous membranes bluish black; the symptoms disappeared in twenty-four hours.

Stirred by these peculiar results, Boehme (8*b*) investigated the nature of the poisoning. He found that bismuth subnitrate, when mixed with human stools, particularly those of children, liberated nitrites rapidly. By injecting a mixture of human stool and bismuth subnitrate into the gut of rabbits he was able to prove the presence of nitrites in the urine.

Routenberg (51) reported a third case of methæmoglobinæmia occurring after the rectal injection of 50 grams of bismuth subnitrate. In 1908 Novak and Gutig (44) published a third fatality due to the rectal injection of two ounces of bismuth subnitrate. The patient, an adult, became grayish green, the mucous membrane cyanotic, the blood chocolate-colored; death occurred in eighteen hours. These authors also undertook experimental investigations. They confirmed Dalché's observation that bismuth subnitrate when given by mouth to dogs produced no toxic effects, but when given to cats it regularly produced death in about ten hours, with

[1] The stomach of the rat, the small intestine of the goose, the large intestine of mammals, and the cæcum of the rooster.

cyanosis and methæmoglobinæmia. In the same year Erich Mayer (39) published a fourth fatal case in which bismuth subnitrate was given by mouth to diagnose an intestinal stricture. A few hours later the patient became deeply cyanotic, the blood showed marked methæmoglobin, and death occurred within twenty-four hours. Chemical analysis showed nitrites to be present in the gut between the two strictures, in the urine and in the pericardial fluid, these symptoms corresponding closely with the picture of nitrite poisoning—Collishon (10), Kobert (28). The chemical demonstration of nitrites in Erich Mayer's case and the experimental work of Boehme, Novak and Gutig, *clearly prove the symptoms to be due not to the metal bismuth but to the formation of nitrites.* Additional weight is given to this view by the findings of Schumm and Lorey (54) who proved the presence of methæmoglobin after the internal administration of bismuth subnitrate, even though no gross toxic symptoms were evidenced.

There are thus three distinct types of intoxication due to the use of bismuth: first, an acute experimental metallic poisoning, of which no clinical cases have been reported; second, a chronic metallic poisoning produced by either the external application or the subcutaneous injection of almost any bismuth salt; third, an acute intoxication resembling nitrite poisoning following the internal administration of bismuth subnitrate.

The intoxications following the use of Beck's bismuth paste belong almost entirely to the second class, chronic metallic poisoning. To this group belong our three cases and the following:

Case 1. Don (16*a*). Female, age 21, tuberculous gonitis. 3 oz. of 33 per cent paste injected; 17 days later, 4 oz. Three weeks later dysphagia and stomatitis; two weeks later, blue discoloration of gums, palate, buccal mucosa, pharynx and lips, knee then opened, bismuth evacuated. Gradual subsidence of symptoms.

Case 2. Beck (5*g*). Adult, male. 16 oz. 33 per cent paste injected into an empyema cavity; after ten days anorexia and lassitude, blue discoloration of gums, blue rings about the tonsils and small ulceration back of the third molar tooth. Bismuth at once withdrawn by olive oil injection. Symptoms disappeared in three weeks.

Case 3. Beck (5*g*). Male, age 57, chronic hip disease. About 400 gms. of pure bismuth injected during period of 60 days. After last injection bluish discoloration and ulceration of oral mucosa, loosening of the teeth, œdema of the lips, albuminuria, and diarrhœa. Remission of symptoms for several months. After injury to wrist, patient gradually weakened and died. Autopsy showed black discoloration of the intestinal mucosa. In the interlobular liver capillaries were numerous small granules supposed to be bismuth. Liver and spleen contained bismuth chemically. The kidneys showed only chronic interstitial changes.

Case 4. David (14). Male, age 24, tuberculosis of hip. 3 oz. of 33 per cent paste injected; three weeks later 6 oz.; ten days later stomatitis, blue line on gums, marked salivation, and impairment of general condition. Bismuth evacuated. In six weeks subsidence of symptoms.

Case 5. Kaufman (14). Male, age 21, tuberculosis of hip. 6 oz. of 33 per cent bismuth injected; ten days later very marked stomatitis, ulceration and swelling of tongue, profuse salivation, acute cervical lymphadenitis, vomit and bloody diarrhœa, complete anorexia, and signs of acute nephritis. Death 27 days after injection. Autopsy showed catarrhal enteritis and diffuse nephritis. The bismuth used contained no impurities.

Case 6. Rosenbach (50). Female, age 25, tuberculosis of hip. 11 injections each of 20 to 30 grams; before each injection sinus irrigated to remove residue of previous injection. After eleventh injection ulceration of mouth, stomatitis and headache. Subsidence of symptoms after washing out sinus. Bismuth pigmentation present five months later.

Case 7. Matsuoka (37). Male, age 15, Pott's disease with lumbar abscess. 60 grams of 10 per cent paste injected. Five days later malaise, stomatitis, and marked constipation. Recovery without further treatment.

Case 8. Matsuoka (37). Female, age 33, Pott's disease with psoas abscess. 80 grams of 10 per cent paste injected. Twelve days later marked stomatitis and fetor ex oris. A week later abscess opened and sero-sanguineous fluid evacuated. Patient did not return to clinic, but her death was reported one month later.

Case 9. Matsuoka (37). Female, age 6, Pott's disease with psoas abscess. 40 grams of 10 per cent paste injected. Thirteen days later black discoloration of gums, buccal membrane and tongue, progressing to acute gangrenous inflammation, necrosis of teeth. Death in six weeks, preceded by vomiting, cramps, and obstinate constipation.

Case 10. Lawson (31). Male, age 27, persistent empyema cavity. Seven injections of 33 per cent paste of 1 oz. each. After sixth injection, stomatitis, salivation and anorexia, urine showed hyaline and granular casts. Remission of symptoms for several weeks, then recurrence. Bismuth washed out with olive oil. Symptoms gradually disappeared. Bismuth pigmentation still present five months later.

CASE 11. Camerer (65). Adult, male, Pott's disease with psoas abscess. 20 cc. of 33 per cent paste injected. Four days later anorexia, languor, occipital headache, soreness of gums, tongue and lips. Five days later bluish gray line on gums, ptyalism and fetor ex oris. Abscess cavity then opened and irrigated with boric acid solution. Gradual recovery.

CASE 12. Anderson (3). Female, age 54, persistent sinus after perinephric abscess. 3 oz. of 33 per cent paste injected. Three days later sore gums. Two days later marked stomatitis and ptyalism. Four months later pigmentation of gums still present and patient complained of pain in the face and jaw.

CASE 13. Eggenberger (19). Male, age 7, Pott's disease with abdominal abscess. 30 gms. of bismuth paste injected. After six weeks gradual loss of appetite, nausea, and vomiting. Stomatitis with blackish brown ulcers on gums and lips. Abscess opened and washed out, but symptoms progressed. Nystagmus and trismus, clonic and tonic convulsions of face and extremities, unconsciousness, rapid stertorous respiration, cyanosis, and death several days after opening abscess. Necropsy showed: 1, hyperæmia of brain; 2, small hæmorrhages in mucous membrane of stomach; 3, redness and swelling of follicles of small gut; 4, a circular greenish brown ulceration 2-3 cm. in dimeter on the valve of Bauhin. Bismuth found chemically in the ulcers of mouth.

The nystagmus and trismus noted here, though not usually present in bismuth intoxication, have been seen in two other cases (Reich, 47, and Windrath, 63) and were experimentally produced by Meyer and Steinfeld (41). The cyanosis is not characteristic of bismuth intoxication and suggests the possibility of some nitrite formation.

Four cases are not sufficiently described to assign them to any category.

CASE 14. Beck (5*d*). Old spondylitis, paraplegia, incontinence of urine and feces for a long time. Died 18 hours after injection of bismuth paste. No autopsy.

CASE 15. Beck (5*d*). Abdominal fistula of long standing following laparotomy. Death four months after bismuth injection with symptoms of severe gastroenteritis. No autopsy.

CASE 16. Reich (47). (Pg. 212, foot-note.) Adult, tuberculous coxitis. Complete anorexia, vomiting, dyspnœa, unconsciousness for two days after injection of bismuth paste. Death. No autopsy.

CASE 17. Lord (34). Empyema. Death with symptoms of chronic bismuth poisoning after injection of bismuth paste.

Each of the remaining two cases differs from usual picture of metallic bismuth intoxication.

CASE 18. Alapy (2). Female, age 10, tubercular empyema. 10 cc. of 33 per cent paste injected. Next day, headache, languor and vomiting. That night sudden blindness; fundi showed early choked disc which gradually became more marked and then subsided; sight returned.

The absence of any other symptoms of bismuth poisoning makes it doubtful whether the blindness was in any way due to it.

CASE 19. Reich (47). Male, age 29, appendicitis sinus. Twelve days after operation injection of about 20 cc. of 30 per cent bismuth paste. After four days fistula closed but granulations black, appetite diminished. After six days headache, dizziness and vomiting. After seven days, complete anorexia, weakness, redness and dryness of mouth and throat. After eight days, mild stomatitis, blackish brown border of gums. After nine days, patient exhausted, pulse small, soft, 124; temperature 40.8° C.; respirations rapid and stertorous; face gray; scleræ subicteric; patient restless, at times stuporous; reflexes increased; spasm and twitchings of extremities; no rigidity of neck. After ten days, tonic and clonic spasms, small superficial ulcerations on gums, urine cloudy, dark brown, containing 1 per cent albumin and numerous granular casts; livid discoloration of mucous membrane of gums; cyanosis of enti e body. After eleven days, death with pulmonary œdema. Autopsy: Blood choclate colored; wall of abscess formed by darkly pigmented gut; petechial hæmorrhages in mucous membrane of kidney pelvis; mucosa of gastrointestinal tract normal, even where serosa was pigmented. Chemically no bismuth in the liver. Spectroscopically no methæmoglobin after twenty-four hours. Microscopically: Kidneys — hæmorrhages in cortex, parenchymatous degeneration, pigmentation in cortex and medulla giving reaction for iron, red blood cells malformed. Spleen — capillary hæmorrhages, iron pigmentation. Liver — parenchymatous degeneration, iron pigmentation. Gut — iron pigment present and another pigment whose nature could not be determined (no micro-chemical tests for bismuth made).

This case was evidently one of combined metallic and nitrite poisoning. To the bismuth can be ascribed the stomatitis and ulceration of the gums, the anorexia, headache and nephritic symptoms; to the nitrites the cyanosis, dyspnœa and methæmoglobinæmia. The tonic and clonic contractions might be due to either of them. The capillary hæmorrhages, degeneration of red cells and hæmosiderosis indicate a marked toxic action on the red blood cells. Whether this is due entirely to the bismuth cannot be definitely proven. Kobert and Schmelzer have shown

that bismuth is deposited in the white blood cells, and in two of our cases the red blood cells showed basophilic degeneration. The absence of changes in the gut is undoubtedly due to the early death of the patient. The case would be of distinctly greater value had the blood been studied microscopically and spectroscopically during life and had search been made for nitrites in the urine, intestine and pericardial fluid.

### II. CLINICAL REPORTS

We are indebted to Drs. Gerster and Lilienthal, attending surgeons to the Mount Sinai Hospital, for permission to report the following cases, all three of which belong to the type of pure metallic bismuth intoxication:

CASE 1. M. B., male, age 22. History of a fall one year before on the right hip. Pain in the right leg and discharging sinus over the great trochanter, of four months' duration. Examination showed the sinus to lead upward and inward toward the lumbar spine. Tenderness and rigidity over fourth lumbar vertebra. Two and one-half ounces of 33 per cent bismuth paste injected into the sinus. X-ray showed a tract leading through the sacro-sciatic notch to the lateral process of the fourth lumbar vertebra. The lateral process itself showed evidence of chronic osteomyelitis. Four days after the bismuth injection, Dr. Lilienthal exposed the fourth lumbar vertebra and removed a sequestrum composed of the greater part of the right lateral process; no evidences of tuberculosis found. Wound drained with rubber tube.

Two days after operation (six days after bismuth injection), the patient complained of soreness of gums and tongue; examination showed them to be inflamed and tender. On the following day two small ulcerations were seen on the under surface of the tongue. The next day the tongue was swollen to one and one-half times the normal size, and at its tip were a number of pin-point bluish black pigmentations. Along the margin of the gums were similar pigmented spots, suggestive of an early lead line, but this pigmentation was blacker and was located at the very border of the gums instead of at a short distance from the border. The patient's breath became exceedingly foul; he complained of intense pain and was barely able to eat. Urine showed a faint trace of albumin, hyaline and granular casts. Blood count normal. The glossitis and gingivitis became more pronounced, and the pigmentation extended to the under surface of the tongue where it formed two broad bands following the course of the ranine veins. A deep ulceration appeared in the buccal mucosa opposite the last molar tooth. Local treatment was of absolutely no effect.

In our ignorance of the picture of bismuth poisoning we were unable to determine the etiology until a chemical examination of the urine was made. Dr. S. Bookman, physiological chemist to the hospital, reported the presence of large amounts of bismuth. Following Beck's treatment, the sinus was then irrigated thoroughly with warm olive oil until X-ray showed no remaining traces of bismuth. Within three weeks the gingivitis and glossitis disappeared and the urine became normal. The pigmentation, however, remained. At no time were there gastrointestinal symptoms. Three months later the sinuses had completely closed and the patient had gained twenty pounds in weight. The pigmentation of the gums and tongue was still present.

Several months later a similar case occurred on Dr. Gerster's service.

CASE 2. Female, age 22, empyema sinus of two months' duration. In an effort to heal the sinus 2 ounces of 33 per cent bismuth paste were injected. As discharge persisted unabated after two weeks, Dr. Gerster decided that operation was indicated. He removed about six inches of the third, fourth, fifth, sixth, seventh, and eighth ribs. On opening the abscess cavity it was found full of grumous material, probably bismuth and pus. Its walls were thickened and plastered with bismuth. The bismuth was evacuated and the abscess walls were curetted.

The following day the patient complained of pain in the mouth and dysphagia. There was then noted a bluish-black deposit on the edges of the gums and on the under surface of the tongue. The pigmentation became more marked and an ulcer developed on the inferior surface of the tongue. The urine was normal for two weeks, then showed a trace of albumin and hyaline casts, and chemical examination by Dr. Bookman revealed the presence of bismuth. The red blood cells showed a basophilic stippling as in lead poisoning. The ulcer healed within two weeks and the pigmentation gradually became less marked, but it was still present when the patient was discharged, eight weeks after the bismuth injection.

In this case the exposure of extensive raw areas to the bismuth undoubtedly aided in producing the toxic symptoms.

Cautioned by these examples of poisoning the use of bismuth paste was discontinued for several months. At the suggestion of Dr. Joseph Wiener, associate surgeon to the hospital, a ten per cent zinc-oxide-vaseline paste was used instead. A persistent empyema sinus in an adult was cured by two zinc paste injections, one in a child by a single injection. We began to congratulate ourselves on the discovery of a safe substitute

for bismuth. Then came disillusionment. About two ounces of zinc paste were injected into the empyema sinus of a child two and a half years old. Five days later he began to run a septic temperature, and for a few days there was almost complete suppression of urine. The urine boiled solid with albumin, contained numerous casts, hyaline, granular and waxy; red blood cells and white blood cells; and, on chemical examination, large amounts of zinc were found by Dr. Kuttner of the chemical department. The acute nephritic symptoms subsided within a week, but after two months the urine still contained casts, red blood cells and a trace of albumin. Between a toxic nephritis and a toxic stomatitis the choice of possibilities favored a stomatitis. Therefore when a case presented itself in which a paste injection was absolutely necessary for diagnosis, we injected, with some misgivings, three ounces of bismuth paste.

CASE. 3. Male, age 18, service of Dr. Lilienthal, gave history of fall on left thigh one year before, and of discharging sinuses over upper third of femur. X-ray failed to show any abnormality of the femur, pelvis or spine, nor could bare bone be felt in the depths of any of the three sinuses present over the outer and anterior aspect of the thigh. Two of the sinuses were superficial and were easily excised and sutured. The third was found, on probing, to lead back of the femur and then upward beneath Poupart's ligament. To determine its course three ounces of 25 per cent chemically pure bismuth paste were injected. A radiograph showed the bismuth deposited in a mass over the flare of the ilium, and enabled us to diagnose an osteomyelitis of that bone.

Five days later the patient complained of sore gums. Two days later there was a distinct bluish-black pigmentation of the tongue and gums exactly as in the first case. Microscopical examination of one of these pigmented areas showed the pigment to be present in the papillæ of the corium (Dr. Mandlebaum). Olive oil was injected at once into the sinuses and an attempt made to aspirate the bismuth. Olive oil injections were given daily, but the X-ray still showed bismuth present. One week later a diffuse, measle-like papular erythema appeared on the trunk and extremities, and lasted two days. The rash was unaccompanied by fever or by any general symptoms. The urine at this time contained large amounts of bismuth (Dr. Kuttner), hyaline and granular casts. Despite toxic symptoms the patient's general condition seemed sufficiently good to justify operation.

Under ether insufflation anæsthesia a four-inch incision was made over the glutei and a fenestra about one and one-half inches in diameter, was chiseled through the ilium. Pathological examination showed inflammation of the bone marrow. No attempt was made to curette the walls of the sinus. The operation had no evident effect on the patient's condition. Blood examination a week later showed: Red blood cells, 5,000,000; hæmoglobin, 60 per cent; white blood cells, 19,400; polynuclears, 83 per cent; lymphocytes, 16 per cent; eosinophiles, 1 per cent. The red cells showed basophilic stippling and vacuolization, very slight anisocytosis and poikilocytosis. Not only the urine but the feces contained bismuth; none could be found, however, in the saliva. Sigmoidoscopy the following day showed the intestinal mucosa to be peculiarly dark, and in the lower rectum were two or three areas of deep brown pigmentation and a superficial ulceration about 2 mm. in diameter. The oral condition now became more pronounced. A black, sloughing area developed over the right tonsil. The upper cervical and submaxillary lymph nodes became enlarged and very tender. The patient's general condition began to deteriorate. He vomited occasionally and complained of great weakness. There was constant, profuse salivation and extreme fetor oris. Three days later bloody diarrhœa began. Despite daily olive oil irrigation of the sinus the gangrenous area over the right tonsil extended to the soft palate and uvula. The patient now presented a pitiable appearance of profound emaciation. The temperature became subnormal (96° to 98°), respiration very slow (5 to 12 per minute), and finally death occurred six weeks after the bismuth injection. Spectroscopic examination of the blood three hours before death failed to show the characteristic band of methæmoglobin (Dr. A. Bookman).

### III. PATHOLOGICAL REPORTS

Autopsy two and one-half hours after death.

General: Body is that of a young man showing marked emaciation. Rigor mortis moderate. No icterus or petechiæ; no postmortem discoloration. Skin and mucous membranes show marked pallor, the face presenting an ashy hue.

Local: On the outer aspect of the left hip is a large wound about thirteen centimeters long, by five centimeters wide, the edges of which are gaping. The wound itself is funnel-shaped leading down to the ilium. The muscle and connective tissue in the wound are covered with pale granulations, those at the bottom being grayish-green in color and apparently sloughing. The portion of ilium exposed measures about four centimeters square and in the center of this is a hole about two centimeters in diameter which goes completely through the substance of the bone. The bone in its immediate neighborhood is very markedly roughened. The soft parts show a deposition of a whitish substance, apparently bismuth.

Heart: Pericardium apparently normal. Heart somewhat smaller than normal. Cavities moderate-

ly dilated. Foramen ovale patent to a large probe. Tricuspid and pulmonary valves show no lesions. Mitral valve shows very slight thickening along the closure line on the aortic cusp. Heart muscle presents the normal brownish-red color and averages 1¼ cm. in thickness. Aortic valves show no abnormalities. Coronary arteries present a few yellowish patches near their points of origin. Aorta narrow throughout its entire length; elasticity greater than usual. Studded throughout its intima, particularly on the posterior aspect, are numerous yellowish streaks running parallel with the long axis of the vessel.

Lungs: A few old fibrous adhesions over the posterior aspect of the right lower lobe. No fluid in the pleural cavities.

Right lung: Voluminous; moderately anthracotic; posterior and inferior third of the upper lobe feels very firm and apparently solid. On section, the lung shows a moderate uniform congestion. The inferior half of the upper lobe consists of numerous small irregular areas which stand out prominently above the cut section and have a grayish-pink color. Most of them are the size of a split-pea and from some of them a small amount of purulent material can be squeezed. Other nodules throughout this portion of the lung present a hæmorrhagic appearance. The posterior and inferior third of this lobe is occupied by a uniformly solid material which on cut section presents a yellowish-gray color, and from it can be squeezed a small amount of purulent material. Lower lobe presents near its inferior surface numerous small patches the size of peas, which stand out prominently above the cut section and are reddish-gray in color.

Bronchi are empty and show moderate injection of their mucosa.

Left lung: Somewhat smaller than right, moderately anthracotic. On section, shows slight evidence of congestion which is more marked near the posterior border. Inferior third of the lower lobe has scattered through it numerous smaller and larger hæmorrhagic nodules which stand out above the cut section. These vary in size from the head of a pin to one as large as a lima bean. Each one is studded with numerous pin-point grayish colored areas.

Liver: Weighs 1260 grammes (2 lbs. 10 oz.). Capsule smooth. Organ is of a reddish-brown color. On section, presents a very peculiar yellowish-brown color and a slight uniform clouding of the parenchyma.

Bile ducts are patent throughout.

Gall-bladder of normal size and contains some greenish-brown mucoid bile.

Spleen: Somewhat smaller than normal in size. Measures 10 x 5 x 2½ cm. Weighs 120 grammes (4 oz.). Surface is smooth and of a steel gray color. On section the organ is dark red and the Malpighian bodies are very large and prominent.

Kidneys: Much larger than normal. Weigh together 1 lb. Kidneys are about equal in size. Capsules strip easily, disclosing a smooth surface of a reddish-yellow color on which a few of the stellate vessels along the outer border show a marked injection. On section, parenchyma shows a marked degree of cloudy swelling. Color is a reddish-yellow. Cortex averages 7 mm. in width, is very cloudy, and presents a granular appearance. There are no evidences of striations. Medullary pyramids stand out prominently above the cut section and show a moderate congestion.

Peripelvic fat normal in amount.

Both pelves and ureters show numerous small petechiæ.

Pancreas: Somewhat smaller than normal. On section, shows a dull yellowish color, otherwise presents no changes.

Retroperitoneal and mesenteric lymph nodes: are enlarged to the size of peas, a few of the former being the size of beans. On section, they present a peculiar dull fawn color and have a glassy appearance. This color appears more pronounced in the peripheral portion of the nodes than in the centers.

Stomach: Moderately dilated and contains a small amount of tenacious yellowish mucus. Mucosa appears slightly thickened, is markedly congested, and shows numerous fine petechial hæmorrhages. There is no evidence of pigmentation.

Intestines: Throughout the small intestine from the pyloric ring to about fifteen centimeters proximal to the ileo-cæcal valve, the mucosa shows a moderate congestion which becomes more marked in the ileum. The entire mucosa is stippled with a very fine black pigmentation and looks as if it were uniformly spread with some very fine black powder. The individual particles are visible only upon close inspection, and at a distance they give the mucosa a steel gray color. The pigmentation is somewhat more marked along the bases of the valvulæ conniventes. This pigmentation is more marked in the duodenum and upper jejunum, extremely faint in the lower jejunum and upper ileum, and again becomes marked the nearer the ileo-cæcal junction is approached. In the lower ileum the crypts over the Peyer's patches are marked by coarser black granules. The terminal six inches of the ileum show a most intense injection, the terminal three inches being, in addition, covered by a dark green exudate. The ileo-cæcal valve is enormously edematous and is covered by a thick green exudate. The cæcum contains about half a dozen adult forms of trichocephalus trichiuris.

The wall of the entire large intestine is thickened and œdematous. The mucosa from the ileo-cæcal valve onward, is more or less uniformly covered by thick greenish-black diphtheritic membrane. In places this presents a very shaggy appearance, in other places small areas are seen in which the membrane has been peeled off, disclosing an ulcerated mucosa which is stippled with the same fine black pigment previously described in the small intestine. These areas of membrane become more numerous as the rectum is approached, and here they are

seen to be covered by a uniform layer of black pigment. The lower rectum presents thick masses of greenish diphtheritic membrane upon all the valvulæ, the mucosa in between being hæmorrhagic and colored with the same pigment.

*Microscopical examination:*

Heart: Striations rather poorly marked. The nuclei vary in size and intensity of staining. There is fairly marked bipolar pigmentation. The small vessels are moderately injected.

Lung: Diffuse broncho-pneumonic process. The alveoli are filled with leukocytes, mostly polynuclear. The blood vessels in the interstitium are markedly injected. Anthracosis is moderate, but aside from this there is no unusual pigmentation.

Kidney: The capsule is of normal thickness. The entire organ shows a most intense parenchymatous change. The glomeruli are practically normal although some show moderate injection. The epithelium in all the tubules is in the most advanced stage of degeneration. Most of the tubules present widely dilated lumina filled with cellular debris and hyaline material. Their walls are lined by very much flattened epithelium of low cuboidal type. In some, the cells resemble the flattened epithelium of Bowman's capsule. Where the epithelium is better preserved, it seems to be immensely swollen and undergoing a granular and fine droplet degeneration. The nuclei in many places are fading. The interstitium in some places shows slight œdema but no actual increase. Throughout the organ the capillaries of the interstitium are intensely congested.

Spleen: Capsule of normal thickness. The Malpighian bodies are small and show no germinal centers. Here and there small vessels show hyalinization of their walls. The section shows very intense congestion. Throughout the organ there are large numbers of phagocytes, which contain yellowish-green pigment.

Pancreas: The parenchyma is apparently normal. The islands of Langerhans are of normal size, relatively diminished in numbers. One island shows a fine droplet degeneration of its cells.

Liver: Capsule is of normal thickness. Parenchyma is rather cloudy but otherwise shows little change except in the centers of the lobules; here many of the cells are moderately degenerated and some of them are filled with smaller and larger droplets. Most of the cells in the centers of the lobules are also studded with some fine greenish-brown pigment. Kupfer cells are rather prominent, particularly in the centers of the lobules, and here an occasional one contains some yellowish-brown pigment. Glisson's capsule is apparently normal.

Adrenal: Capsule normal. The zona pigmentosa is poorly marked. The medullary cells are well chromed. There are a few small extra-cortical adenomata.

Small intestine: Shows a small amount of necrosis, involving the most superficial portion of the mucosa. The mucosa itself is intensely injected.

Large intestine: The entire mucosa is necrotic. The deeper portions and the adjacent part of the submucosa are infiltrated with polynuclear leukocytes. There is no evidence of any abnormal pigment. The rest of the submucosa appears thickened and œdematous and intensely congested. Here and there it is studded with collections of polynuclear leukocytes. The muscularis shows no change. The serosa appears slightly œdematous.

Tissue from site of wound: The greater part of the section consists of granulation tissue. This granulation tissue is filled with crystalline material arranged in both smaller and larger clumps and also scattered diffusely through the tissue. These crystals are oblong in shape. On direct inspection the larger masses are yellowish-white in color. Examined microscopically they are yellowish-green and olive green in color. The entire granulation tissue is studded with large numbers of mononuclear cells, the cytoplasm of which is filled with the same material. The spicules and granules are of the same material. In some places these phagocytes, filled with granules, are seen invading the deeper tissues and even the muscle in the section.

Micro-chemical tests: Because of the iron pigmentation found in Reich's patient and in some of Schmelzer's experimental intoxications, hæmosiderin reactions were made on the kidney, spleen, liver and granulation tissue of the wound. The spleen showed a small amount of hæmosiderin, otherwise none was present in the tissues examined.

To determine whether bismuth was microscopically present, a second series of microchemical tests was made on the lung, kidney, spleen, liver, intestine, and granulation tissue of the wound. This test consisted in the conversion of whatever salt of bismuth was present into a chromate and then into the black oxide of bismuth by the action of a weak alkaline solution of tin protochloride. The first step was accomplished by fixation of the tissues for twenty-four hours in formol-Mueller (Orth's) fluid, which contains two per cent of potassium bichromate. After thorough washing in water, the tissues were embedded in paraffin, thin sections cut, and deparaffinized. The sections were then treated with solution of tin protochloride for two or three minutes. This solution was made by dissolving one gram of tin protochloride in about 15 cubic centimeters of distilled water. Then, while constantly agitating the test tube, a forty per cent solution of sodium hydrate was added rather rapidly until the

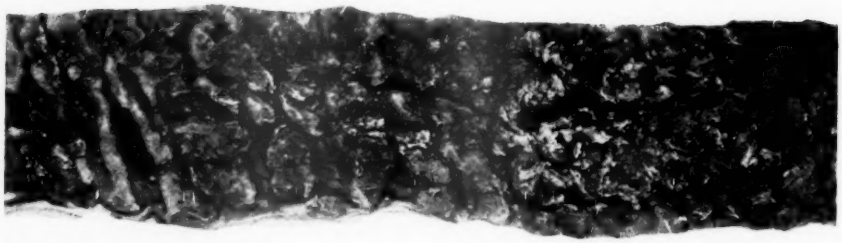

Fig. 1. Photograph of colon, showing ulceration and necrosis. (Wm. Dunn, Loomis Laboratory, New York City.)

reagent became clear. To accomplish this, usually 4½ to 5 cubic centimeters were needed. The resultant solution was then diluted to 100 cubic centimeters with distilled water and filtered through hard filter paper. (This solution must always be freshly prepared.) After treatment with this reagent for two or three minutes the sections were washed in several changes of distilled water for five minutes. During this step considerable difficulty was often encountered in keeping the section on the slide. The specimens were then counterstained in lithium carmine (Orth), cleared in xylol and mounted in Canada balsam.

Chemical analyses: For the following chemical analyses (and for the qualitative analyses of the bismuth excreted in the urine of other cases after its administration by mouth) we are indebted to Dr. Theodore Kuttner. These data have been recently presented by him before the American Chemical Society:

| | $Bi_2O_3$ per 100 gm. | Weight of Organ | Total Bismuth in Organs |
|---|---|---|---|
| Liver | 0.0056 gms. | 990.0 gms. | 0.04890 gms. |
| Kidney | 0.0008 gms. | 480.0 gms.* | 0.00346 gms. |
| Spleen | 0.0022 gms. | 120.0 gms. | 0.00238 gms. |
| Large Intestine | 0.0037 gms. | | |

## IV. DISCUSSION

That death was due to bismuth poisoning cannot be doubted. The clinical picture corresponding closely to that of experimental bismuth poisoning, the presence of bismuth in the feces and urine, the chemical purity of the bismuth injected, the pathological findings at autopsy and the chemical demonstration of bismuth in liver, kidney, spleen, and intestine are conclusive evidence. The absence of methæmoglobinæmia and cyanosis and the gradual course of the disease eliminate any element of nitrite poisoning. Certain features of the case are of peculiar interest.

First, the rash. This appeared ten days after the injection and resembled the exanthem of measles so closely that despite the absence of constitutional symptoms, isolation was advised. We have found reports of two similar exanthemata occurring in cases of bismuth poisoning (Windrath, 63, and Martens, 36). In both cases, as in ours, the rash lasted only two days.

Second, the blood picture. Though Kobert states that bismuth has a toxic action on the red blood cells, we have found no report of actual changes in the red cells produced by bismuth poisoning. In two of our cases the red cells show granular degeneration or stippling, such as occurs most commonly in lead poisoning and is also found in poisoning by copper, cobalt, thallium, and carbon monoxide (Wood, 64). Some of the red cells also showed vacuolization and slight polychromatophilia. The granular degeneration is probably due, as in lead poisoning, to the toxic action of the heavy metal.

Third, the sub-normal temperature. Though this symptom may have occurred in other cases of chronic bismuth poisoning, it has not been emphasized as a feature of the severe types of intoxication. In our patient, despite the presence of an extensive bronchopneumonia, the temperature ranged from 96° to 98° during the three final days of the illness. This symptom was experimentally produced in dogs by Steinfeld and Meyer.

*Both kidneys.

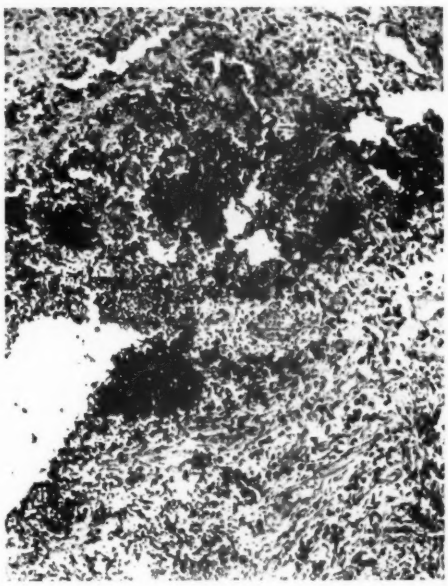

Fig. 2. Photomicrograph of granulation tissue of the wound, 3d case, showing bismuth granules stained by micro-chemical reaction (see text). x 80.

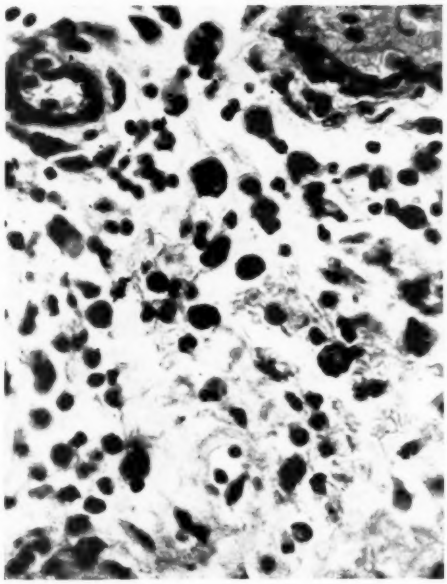

Fig. 3. Photomicrograph of granulation tissue of wound, 3d case, showing bismuth granules within the leukocytes, special micro-chemical stain (see text). x 400.

Fourth, the dosage was small, less than six grams of pure bismuth, and the injection was given under little pressure into a chronic sinus, whose walls were formed by a thick layer of granulation tissue. Apparently the conditions were most favorable for the Beck treatment. We were, moreover, on guard for symptoms of poisoning, and as soon as they occurred we instituted thorough treatment by olive oil injections as advocated by Dr. Beck. Despite the treatment, the bismuth could not be entirely removed. This was possibly due to the bottle shape of the tract and the collapsible quality of the walls which prevented effective aspiration. Beck's warning not to curette the sinus wall and our own experience in the second case, where after such a curetting, the toxic symptoms promptly appeared, prevented us from adopting more vigorous measures to remove the bismuth. Whether we could have saved the patient by any change of treatment is certainly doubtful. He evidently possessed a marked susceptibility to the toxic action of bismuth, just as some individuals are susceptible to iodoform.

The significant fact for the surgeon is that many people are thus susceptible to bismuth; 64 cases of poisoning with 24 deaths ought to be a warning against its use. Beck and his brothers consider themselves fortunate in "not having had a fatal case in their large series," but Beck (5*f*) himself admits that in 30 per cent of his cases there has been pigmentation of the gums, showing the absorption of bismuth and its potentially toxic effects. With this possible toxic action in mind is it advisable to use bismuth paste? Would it not be wiser to search for some less dangerous drug? We ourselves have tried zinc and found it fully as dangerous as bismuth. At present, we are using a vaseline paste containing 33 per cent of magnetic iron oxide. Our series thus far is too small to report, but the therapeutic results have been good and there has been no toxic effect. The preparation of the paste, however, is not easy. Its X-ray shadow is not as heavy as that of

bismuth and its extensive administration by this method may lead to toxic symptoms similar to those following the experimental injection of soluble iron salts—dyspnœa, vomiting, diarrhœa, and albuminuria (Cushny, 11).

Fifth, the pathological and chemical findings are of peculiar significance in helping to clarify our knowledge of bismuth absorption and elimination. Most observers have considered the absorption of bismuth salts from granulating surfaces to be due to the formation of a soluble albuminate. Probable though this theory is, another equally important mode of entry, as shown by the microscopical picture of the granulations of the injected sinus, must be by the action of phagocytes. These cells containing numerous granules of bismuth could be seen not only in the superficial layers but even extending deep into the muscular planes. This observation corresponds with the demonstration of bismuth in the "wanderzellen" of the intestinal mucosa (Steinfeld, Schmelzer, Langhans). The exact fate of the absorbed bismuth cannot be stated. In our case it was demonstrated chemically in the liver, spleen, and large intestine; by Dalché also in the lymph nodes; by Feder-Meyer also in the bone. That micro-chemical tests failed to show bismuth in these organs simply indicates the absence of granules large enough to be visible with the microscope. In view of the large quantities demonstrated by gross chemical tests, we must assume its diffuse presence in the tissues. Its excretion occurs chiefly through the kidneys and gastro-intestinal tract. Some observers have also found it in the saliva, milk (Lewald, 32), and bile (Steinfeld, 41, Wichert, 61). Even when given by mouth bismuth can be found in the urine. In a case of gastric ulcer, given one ounce of bismuth carbonate, Dr. Kuttner found 23 milligrams of bismuth in the urine on the sixth day after administration. In its excretion it produces a marked toxic effect. The nephritis, as evidenced clinically and microscopically in our fatal case, was comparable to the severest form of mercurial poisoning. The large quantity of bismuth excreted by the kidneys contrasted with the relatively small quantity demonstrated upon chemical examination, indicates that these organs do not store the metal as does the liver, but actively excrete it. The changes produced in the large intestine are equally marked. Here there was necrosis of the entire mucosa from the ileo-cæcal junction to the anus. In the small gut there was only slight superficial necrosis. Why there should be so sharp a line of demarcation between the large and small gut can only be conjectured. Meyer and Steinfeld supposed it to be due to the presence of hydrogen sulphide in the large gut—which, precipitating the bismuth as a sulphide, caused a mechanical blocking of the blood—and lymph vessels. Schmelzer, however, questioned their explanation, because in the goose, in whose gut no hydrogen sulphide is present (Tappeiner, 59), similar pathological changes are found. Moreover, if the hydrogen sulphide is the essential cause of the necrosis, the line of demarcation ought not to be sharp, since the confines of the gas are not sharply limited. The changes are probably due to a direct toxic action as in the kidney and are more marked in the large gut because, for some unknown reason, bismuth is excreted to a greater extent by the large gut than the small.

## CONCLUSIONS.

The *practical conclusions* from this study of bismuth poisoning are clear:

1. Bismuth is readily absorbed from a granulating surface.

2. When absorbed, it may have extremely toxic effects.

3. It should, therefore, never be applied as a dusting powder (dermatol) or salve to extensive granulating areas.

4. Beck's bismuth paste should be used only with the greatest caution. Although small quantities (5-10 grams) cannot be considered dangerous, the possible toxic effect should be constantly be kept in mind even with these small quantities, and, at the slightest evidence of intoxication, the bismuth should be thoroughly evacuated. In Reich's fatal case, less than 25 grams of paste were injected.

5. When larger quantities of paste are

required, some less toxic drug, as magnetic iron oxide, should be used.

Two new features are to be added to the clinical picture of bismuth poisoning:

1. Stippling of the red blood cells.
2. A morbilliform rash.

Our pathological and clinical studies have shown that:

1. Bismuth is absorbed from granulating areas largely by the action of phagocytes.

2. A micro-chemical test is necessary for the identification of pigment granules in tissues containing bismuth by chemical examination.

3. Bismuth may be chemically present and even produce marked pathological changes — as in the kidney and colon — yet not be visible microscopically.

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# PROCIDENTIA UTERI

## SUPRAPUBIC PLICATION OF VAGINA AND CONJOINED SHORTENING OF UTERO-SACRAL AND BROAD LIGAMENTS[1]

BY WILLIAM M. POLK, M. D., NEW YORK CITY

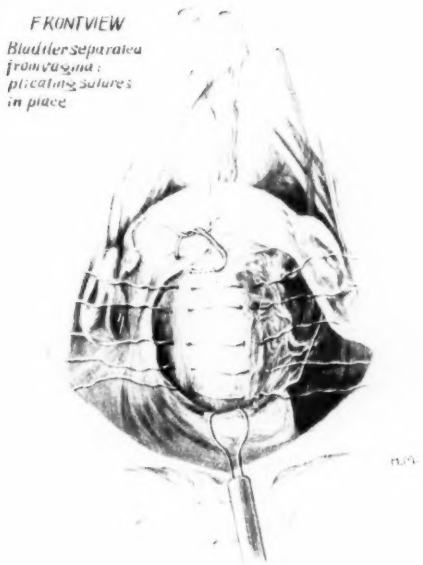
THE conclusions formulated by the operation for procidentia uteri suggested at the close of this paper are based upon the inadequacy in my hands of other forms of operation which I have employed from time to time. Convinced of the insufficiency of the lower supports I began with the introduction of the Alexander operation to employ the upper supports. The Alexander operation, associated with high amputation of the cervix uteri as a means of diminishing the weight of the organ, was employed for a time; then ventral suspension of the uterus by the fundus; then amputation of the uterus at the cervix and ventral suspension of the stump; then amputation of the uterus with the bringing together over the stump of all the uterine ligaments, broad, round, utero-sacral and utero-vesical, holding them by a kind of purse-string arrangement of the ligatures or by a process of overlapping. The last procedure was reported to this society at its meeting in May, 1909. The others are to be found in the New York Obstetrical Society reports. In addition to these I employed the other methods which have from time to time been suggested by other operators during the last thirty years.

Convinced that the preservation of the circulation and nerve supply, belonging to the uterus, is an essential to the success of any operation for procidentia, I finally concentrated my attention upon the procedure which I will explain. The essential element is the utilization of all the direct supports of the uterus and vagina; the broad and utero-sacral supports being shortened conjointly, which process may or may not include the round ligament and must be executed so as to spare the blood and nerve supply to the uterus. The utilization of the vaginal supports through plication of its anterior surface (taking in the slack) as far down as the urethra, in fact pulling the sides of the vagina to the center by the plicating sutures; then dealing from below with the inverted vaginal wall, so as to give the utmost possible support to the base of the bladder. The support thus offered to the base of the bladder, together with the utilization of the direct supports of the vagina and uterus, constitute the cardinal features of the operation.

Before submitting to you the details of the operation, I desire to say that the extensive separation of the bladder and ureters from the vagina, which is necessary, causes far less hæmorrhage and shock than I anticipated; so little, in fact, that in but one case was it a feature of the procedure. I have found also that the more complete the prolapse the easier this separation can be made. I have been unable to complete the procedure in less than one hour and thirty minutes. More facile operators however would find no difficulty in shortening this time materially.

[1] Read before the American Gynecological Society, Baltimore, May, 1912.

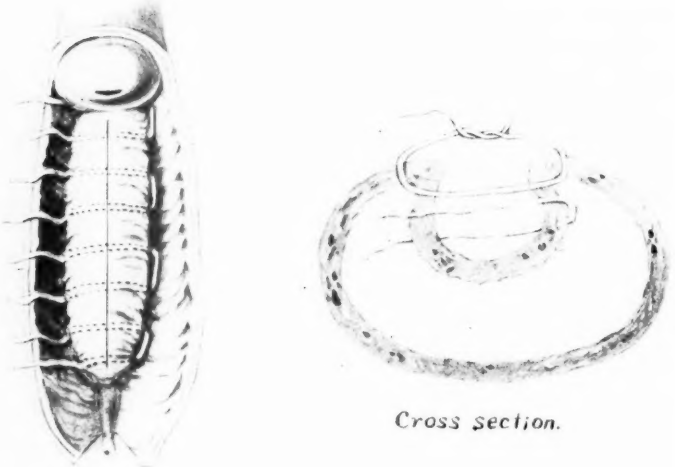
REAR VIEW
Suture thrown around sacral fold after penetrating Broad Ligament.



FRONTVIEW
Bladder separated from vagina; plicating sutures in place

Breaches in the perineum and rectoceles may be corrected later, if condition of the patient should forbid it at the time of this procedure.

The operation is as follows: When you have cleansed the vagina paint it over with strong tincture of iodine. Opening the abdomen the pelvis is freed and kept free of all movable coils of intestine. The uterus is now firmly grasped at vaginal junction with a bullet forceps, and the structures put on the stretch forward and upward. Grasp the broad ligament and the utero-sacral fold between the thumb and forefinger; locate the uterine artery where it leaves the uterus and curves outward towards the main trunk. The thumb being in front and against the uterus, you will have the ureters just at its outer side, behind the artery and extending outward and backward; pass a suture from before backward through the structures held in grasp, entering about half an inch above the artery and about one-third of an inch from the uterus, emerging beneath the utero-sacral fold about one inch from uterus, according to the amount of elongation of this fold. The outline of this suture can be detected by touch, insuring its avoidance of the ureter which is to its outside. Doubling it back above the utero-sacral fold and through the broad ligament below the ovarian ligament it is passed deep into the anterior aspect of the utero-vaginal junction; the loose ends are then temporarily held with a pair of forceps. A suture is passed and secured in similar manner on the opposite side. If these sutures are drawn tight and tied now, the subsequent manipulation upon the vagina may disarrange them. The peritoneal covering is now slit from the uterus to the bladder, the vagina being held taut upward. Through this opening (it may be enlarged by lateral incisions if necessary) the bladder is separated from the entire anterior face of the vagina as far as the urethra in extreme cases. This separation is made best with the gloved finger covered with gauze, or with gauze in a sponge holder, the grip of the gauze displacing the tissue with the least risk of injury to important structures. In this separation if one keeps to the vaginal wall, which is recognizable by its smooth and yellowish white structure, the ureters are pushed up and away from this canal, especially opposite the




Diagrams showing plication of vagina.

line which the first plicating suture must transfix. This line is as far down as possible upon the anterior surface of the vagina (about opposite the trigone). Seize the side of the vagina with a bullet forceps, taking a generous bite, draw it up and pass the suture from without in, repeat this on the opposite side from within out. In this fashion the vagina is plicated from below upward. The number of sutures required depends on the length of the vagina, rarely more than four are necessary; the arteries and veins are tied when necessary. Hæmorrhage is rarely a troublesome feature and always easily controlled; rents in the cavity of the bladder are easily corrected, but need not occur.

The next step is shortening the lateral and posterior attachments of the uterus — the base of the broad ligament and the utero-sacral fold. To this end the sutures already in position are drawn taut and tied. This brings all of the attachments included well forward, and shortens them up effectively on each side. The next step is to bring the peritoneum together along the line of your incision, taking in any slack that may exist therein. In this connection the round ligaments and peritoneum may be utilized. That is, the round ligaments can be caught up about an inch and a half from the uterus, brought together and fastened down at the utero-vaginal junction. This may be done separately or by means of the same suture which encircles the utero-sacral folds and base line of broad ligament. If the fundus then needs to be brought forward you may seize the round ligaments an inch further out and attach that point to the uterus where the ligaments originate. It is now necessary to get the peritoneum which belongs to the anterior face of the broad ligament well down into the utero-vesical space, so as to make the fossa as shallow as possible between the uterus and the bladder. In this way you check the first effects of abdominal pressure; you meet it at the highest point in the field. The abdominal wound is now closed and the vagina becomes the field of operation.

More or less of a ridge will be found upon the central line of the anterior vaginal sur-

face. Seizing this fold at the lowest point with a pair of artery forceps you cut directly into it; the introduction of the director will then enable you to slit it from below upward quite to the uterus without danger of interfering with the sutures that you used in the suprapubic plication. The two folds of the vagina may now be treated as conditions require. You can remove as much or as little as the judgment of the operator may suggest. My own feeling is that little or perhaps none of this fold need be cut away. The surface exposed may be brought together by chromicized gut, which may be put in either separately or continuously, as the exigencies of the case require. If preferred this fold may be left intact and its opposite surfaces stitched together by through and through sutures. If the condition of the patient is good and the perineal body needs repair, as it usually does, this may now be done. This closes the operation.

It is quite evident that should we remove the entire anterior wall of the vagina as far down as the urethra, instead of plicating it, the operation would be shortened and simplified. Then one need only bring the cut edges at the sides together at the middle line to bring into play all lateral supports, but the result would be no better than plication gives; in fact inferior, because the column secured by plication gives direct support to the bladder where it is most needed; moreover, if, through any untoward accident or influence, the base of the bladder again descends, it would find adequate covering in the one case, with the other it might not. It is entirely feasible, however, to remove the anterior wall in lieu of plication.

In two of my cases I found the utero-sacral folds so well developed and elongated that I drew them forward along with the base line of the broad ligaments and joined them together in front of the uterus, but it is well to realize that the utero-sacral fold is sometimes a very disappointing structure. Clearly outlined both as regards location, and direction, and well developed, it is readily found, but in some cases it may lack distinctness, and instead of passing directly back toward the sacrum as we hope for, we find it branching off to the right and left and presenting indistinct lines of attachment to the lateral posterior pelvic walls on the two sides. In these cases I have found that the lateral attachments of the uterus as represented in the base lines of the broad ligaments are stronger and more developed than in cases in which the utero-sacral folds have the expected growth. In all of my cases I have met with evidences of shock in but one instance and this was a case that required more manipulation behind the uterus than I have used in my later cases. Such hæmorrhages as occur are easily controlled. Most of it is venous, which as a rule has ceased by the time the operation is over. The arterial hæmorrhage, if any, is readily controlled. Of course the vital points in the situation are the ureters, but by keeping close to the vagina in separating the bladder, especially as you approach the lower part of the field, and by carefully inspecting the portion of the vagina at which you pass your sutures, this danger is readily avoided. All sutures except those used for vessels and for closing the peritoneum ought to be of good-sized kangaroo tendon.

A sharp lookout must also be kept as to the ureters when you pass sutures through the broad ligaments and utero-sacral folds, especially in cases in which the latter are ill-defined and incline to lateral rather than sacral attachments. These lateral folds usually run quite close to the ureter as it reaches out towards the pelvic wall.

The conjoined shortening of the broad and utero-sacral ligaments is easier and more satisfactory than shortening each separately. The fact that the essential fibres of each are continuous at the sides of the uterus, justify this step anatomically.[1]

I submit seventeen cases as examples, eight within time limit, two years. In every case the uterus rested entirely without the body, or as far out as midway the cervix. One case reported is a prolapse of the vagina and bladder following removal of the uterus years before for procidentia. Treatment by pessary had been tried in all these cases, with failure in each one.

[1] My thanks are due Mr. A. G. Crawford and Mr. J. Miller, students at Cornell University Medical College, for the dissections, and to Mr. Murayama for the drawings showing the dissections and operation.

CASE 1. P. E. Age 33. Born U. S. Occupation nurse. Admitted to hospital October 2, 1911. Discharged December 11, 1911. Diagnosis: Displacement of uterus. Complication: Relaxation of pelvic floor. Prolapse second degree. Uterus half out.

Family history negative. Previous history good.

Present illness: Onset several years ago with sudden cramp-like pains in lower part of abdomen. Patient thinks it was caused by a sudden strain on lifting a patient. Next day pain was still present but less severe. Relief followed rest in bed. Since that time patient has been troubled by weight and dragging in pelvis; a feeling of falling out in perineum; occasional nausea and a tendency to tire easily. After a time patient noticed that her cervix was pressing down into vagina and it has at last gotten so low that it protrudes between the labia after standing for some time. Difficulty in voiding urine, sometimes not being able to void without pushing up the uterus. Tendency to constipation. Discomfort greater with constipation. No leucorrhœa. Slight loss of weight. Medium height and stout. Organs normal. Sexual organs: External genitals normal. Perineum relaxed. Vaginal walls prolapsed. Cervix conical. Os closed; soft. Uterus low down in vagina; can be drawn down and brought completely outside of vagina through vulva. Adnexa: Negative, except for general relaxation of all ligaments.

October 11, 1911. Operated October 10th. Slept little during night. Considerable pain in bladder region. General condition good. Bladder draining well through retention catheter.

October 12. Doing well. Slight pain. Appetite good. Catheter removed. Has had a few R. B. C. in urine and many U. B. C. Slight pain on voiding.

October 17. Sutures removed. Wound clean and healed. Abdomen strapped.

October 23. Dressing removed from wound. Urine showed some increase in pus. Bladder irrigated with boric acid 4 per cent q 2 d beginning October 21st. Irrigation followed by argyrol 10 per cent oz. 2. Up in bed.

October 25. Abdomen restrapped. Bladder irrigations discontinued October 25th. Up in chair 2 hours.

November 6. Ordered up about ward. Condition fine.

November 10. Operation on perineum, November 9th. Very little pain.

November 12. Vaginal douche boric acid 4 per cent q 2 d. Irrigate perineum boric acid 4 per cent b. i. d.

November 14. No complaints. No pain. Slight vaginal discharge with slight odor.

December 11. Discharged. Patient examined standing. Uterus in excellent position. No vaginal prolapse.

*Operation.* Prepared in usual manner. Incision 5 inches long in mid-line above pubis opening abdomen. Trendelenburg position. No adhesion. Intestines pushed up and packed with gauze roll in keeping intestines free from operating field. Uterus low down in pelvis. Fibroma large as a chestnut on posterior surface of uterus near right cornu. Peritoneum incised transversely between bladder and uterus. Bladder inclusive of trigone separated from anterior surface of uterus and vagina by blunt dissection. Ureters identified and kept free from field of suture by upward and outward traction. Sutures of strong kangaroo tendon passed through lateral wall of vagina on one side, then emerging and passing anterior to anterior vaginal wall to take a similar bite on opposite side, plicating this anterior wall from below upward, from region of trigone to uterovaginal junction. Five such sutures passed and tied. Round ligaments drawn together in front of uterus and sutured together with Pagenstecher. Peritoneum sutured together over field of operation. Utero-sacral ligaments caught with bullet forceps drawn together and sutured behind uterus with Pagenstecher suture. Small fibroid enucleated and site covered with peritoneum. Abdomen closed as usual. Retention catheter in bladder. Bloody urine oz. 4. Sterile dressing. To bed in good condition. No drain.

April 1, 1912. Reported as doing well.

CASE 2. M. Ph. This patient duplicated in all essentials the preceding case, similar in height, both maidens, and stout, this one of the leisure class, however. Operation the same in all particulars except that here conjoined shortening of utero-sacral and broad ligaments was done and the rectocele and perineum were treated at time of main operation. March 5th was the date of this operation with a result at this date, April 1st, as good as the best.

CASE 3. D. M. Age 38. Born U. S. Occupation housework. Admitted to hospital October 24, 1911. Discharged December 21, 1911. Diagnosis: Prolapse of uterus. Complication: Double salpingitis. Laceration of pelvic floor.

Family history good. Previous history good. Present illness: During delivery, 17 years ago, patient's perineum was badly torn and symptoms of the present condition began shortly after that time. The first symptoms noticed were a sagging sensation in the perineum and a feeling of weight in the pelvis. She next began to have lumbar backache, pain radiating from the backs of the thighs, and a feeling of something dropping out below. At first this feeling amounted to only a sense of fullness in the vagina, but gradually it grew more pronounced and soon the patient noticed that the vaginal wall seemed to protrude between the labia. This condition progressed until the cervix and finally the whole uterus would protrude from the vaginal orifice whenever the patient would stand for any length of time or strain at stool. During this time the headaches, backaches, and pains in the limbs have been growing steadily worse. Four months ago the patient began to have a profuse brown

vaginal discharge after each menstrual period, lasting for about a week. Since onset of the present condition patient has had slight frequency of urination. Sex organs: External genitals, normal. Perineum, extensive old laceration extending to left side of body of perineum. Vagina: Outlet large, gaping. Very roomy. Walls lax and prolapsed. Cystocele and rectocele. Cervix: Fairly large and long in vagina. Uterus: Prolapsed; can be made to descend through vulvular orifice. Adnexa: Relaxation of all ligaments.

*Operation.* Suprapubic repair of pelvic floor. October 30, 1911. Prepared as usual. Incision 5 inches long in mid-line above pubis. Trendelenburg position. Both Fallopian tubes distended to one and one-half inches in diameter, angulated, somewhat adherent. Tied off at infundibulo pelvic ligament and at uterine end of tubes and both tubes and ovaries cut away. Vesico-uterine peritoneum divided transversely; bladder separated from anterior uterine and anterior vaginal wall well down. Ureters identified and pushed outward from vagina and upward with the trigone of bladder. Sutures of kangaroo tendon passed through lateral columns of vagina from below upward, brought out and tied in front of anterior vaginal wall, thus taking in a reef. Utero-sacral ligaments caught up; threaded with a suture; suture passed through base of broad ligament with Cleveland carrier on either side. The ligament sutured to anterior surface of vagina at level of cervix. Divided peritoneum closed. Round ligaments caught up and shortened by suturing to anterior surface of uterus with Pagenstecher linen. Wound closed in usual manner. Sterile dressings. To ward in good condition. Convalescence uneventful.

November 20. Perineum repaired.

December 21. Discharged. Uterus in good position. Cervix still too long; not involuted.

April 20. Examined standing as before. Utero-vaginal junction in normal position. Cervix still too large but not protruding. Should have been amputated.

Case 4. M. W. Age 42. English. Occupation, housework. Admitted to hospital May 17, 1910. Discharged June 23, 1910. Diagnosis: Prolapse of uterus. Family history negative. Present history: Ever since birth of first child twenty-six years ago patient has been complaining of sensations of prolapse of pelvic viscera. She has always been of the opinion it was the uterus came down but never came outside. Associated with this she has had backaches of a dragging, bearing down nature but no other pains. Never was treated except once, ten years ago, when she received no relief from pessary tampons and douches. Condition has become progressively worse and for past six months has been feeling weak and run down. Has been troubled with headaches, whitish discharge and occasional vomiting. Comes to hospital on account of prolapse.

General appearance. Rather elderly woman. Poorly developed and nourished. Does not appear acutely ill. Heart normal in size, shape and position. Apex beat in fifth space three and one-half inches from mid-sternum. Sounds of good quality. Not roughened or accentuated. No murmur or thrills. Action good. Arteries rather large but soft. Pulse regular in rate and force; good force and tension. Lungs, chest, fairly developed. Expansion good and equal. No impairment at resonance or changes in breath; sounds, voice or tactile fremitus. No rales heard. Abdomen, soft and relaxed. No tenderness, rigidity or muscular spasm. No masses. Liver, spleen, kidneys not palpable Muscles, bones, joints negative. Lymph nodes not large. Skin negative. Reflexes normal.

Pelvic examination, external genitals negative.

May 21. Patient's general condition is improved. Constipation has been very stubborn.

May 25. General condition much improved. Intestinal condition better. Locally less congestion. Patient stronger, pulse fuller and better quality.

May. 27. Operated. Dr. Polk's operation on pelvic floor. Patient recovered from ether well, with some vomiting.

May 28. Patient has experienced no excessive post operative pain. Had some cramp-like pains general in region of colon. Passes urine well. Cathartic given.

May 30. No complications. Patient is very comfortable. Bowels move well.

June 3. General steady improvement. Sutures removed. Wound clean.

June 6. General condition shows steady improvement.

June 10. Some temperature. Patient feels well. Wound clean and no tenderness.

June 12. As before. Wound clean but some slight tenderness about upper part of wound and sense of induration deep down. Small opening made in scar but no pocket found. Strip of gauze to keep opening.

June 14. Dressed gauze taken out and scissors out down to induration which is softer. Pus obtained. Finger and scissors enlarge opening and cavity irrigated and pocket with gauze.

June 15. Comfortable. Dressed. Wound shows very little discharge.

June 16. Examined by Dr. Polk. Good position. Some induration. No pain. No prolapse.

June 23. Discharged. Condition excellent generally and locally. Good position. No pain; no prolapse. To return for observation.

Operation. Patient and field of operation prepared in the usual manner. Incision median about 4 inches long ending 1 inch above symphysis. Abdomen opened and patient placed in Trendelenburg position. Uterus found abnormally movable and all pelvic ligaments stretched. Uterus grasped at cervico-uterine junction by bullet forceps and drawn upward. Peritoneum incised and widely reflected. Bladder with ureters separated from

vaginal and uterine walls and retracted. Kangaroo tendon sutures placed transversely across vagina. Whole venous system in region congested and varicosed and bleeding is excessive; controlled by the sutures. Five plicating sutures put in, one or two perforating into vagina.

Peritoneum closed by plain gut sutures running up onto face of uterus and approximating round ligaments at fundus. Sacro-uterine ligaments identified and shortened by kangaroo tendon sutures. Peritoneum and fascial planes closed by catgut and skin by silkworm gut. Last report: Uterus in good position.

CASE 5. B. R. Age 26. Occupation, housework. Admitted to hospital May 26, 1910. Discharged June 24, 1910. Diagnosis: Prolapse of uterus. Complication: Laceration of perineum.

Family history negative. Present illness: Began eight days after child was born, as a pain followed by a prolapse of the uterus. Patient came to Bellevue clinic in December and was treated by pessary which supported uterus until March, when some inflammation set in. Rings were removed and patient put on douches. Since March she has had a yellowish leucorrhœal discharge. Uterus has been down since that time.

June 6. Operated upon as follows:

*Operation.* Patient and field of operation prepared in the usual manner. Incision median about 4 inches long ending 1 inch above symphysis. Abdomen opened and patient in Trendelenburg position. Uterus grasped at cervical junction by bullet forceps and drawn upward. Incision into peritoneum over utero-vaginal junction and peritoneum reflected widely. Uterus and vagina separated from bladder and ureters which are retracted from the operative field. Plicating sutures of kangaroo tendon placed laterally drawing together the vaginal wall anteriorly. Peritoneum closed well up on to face of uterus with catgut, the upper two stitches approximating the round ligaments in front. Uterus held well forward and the utero-sacral ligaments identified. Each shortened with kangaroo tendon. Perineum closed with catgut as were fascial planes. Skin with silkworm gut. Dressed.

Patient placed in lithotomy position. Incision between rectum and vagina running up to site of old fourchette. Vaginal wall dissected free from rectum and lateral walls of space so left closed with catgut. Skin closed with deep sutures of silkworm gut. Dressed and returned to ward in good condition.

CASE 6. L. L. Age 35. Russian. Occupation, housework. Admitted to hospital November 10, 1909. Discharged January 13, 1910. Married 11 years; 3 children; 1 miscarriage.

Pelvic examination. External genitals: Normal. Bony pelvis: Normal. Pelvic floor: Second degree laceration. Cervix: Median, central, bilateral laceration, bands of scar tissue binding lip of cervix to anterior wall of vagina and to right lateral wall. Uterus: Prolapse in first degree, with cystocele. Adnexa: Normal. Vagina: Roomy. Operation November 15th.

January 13, 1910. Vaginal examination shows little or no discharge. No pain or tenderness except in perineum. Uterus and cervix very high up in vagina. Movable and not tender. Cervix somewhat soft and not patulous. Body of uterus not palpated. Ovaries not palpated; fairly firm bands felt stretching across both fornices laterally, but not making the cervix immobile. Complains of dull, not constant pain over lower abdomen and bladder and in lumbar region of back. No pain on urination. No incontinence. No urgency. Sometimes pain at end of urination. Urination always relieves her pains.

January 8. Complains of dull constant pain in right and left flank. On examination condition is as last noted. Urinary condition improving.

January 10. No change.

January 25. Returned for examination. Cervical stenosis followed second operation and was later broken up. Examined to-day by Dr. Polk. Conditions noted, uterus returned to normal position. Some induration at base of broad ligament on both sides; most marked on left. Patient just complained of pain at menstruation two weeks ago.

April 5. Examined by Dr. Polk as follows: Uterus in good position. Still complains of pains in region of broad ligaments. Tenderness insignificant.

*Operation.* Laparotomy and plastic for support of uterus. Patient and field prepared in usual manner. Median incision four inches long made through skin and subcutaneous tissue. Muscle fibres divided. Peritoneum divided. Vagina separated from posterior wall of bladder by blunt dissection, then plicated. Infundibulo pelvic ligaments shortened. Utero-sacral ligaments shortened; wall of vagina sutured and slack taken up from within abdominal cavity. Peritoneum sutured with catgut; muscle and fascia with plain catgut. Skin sutured with silk. Patient returned to ward in good condition.

Operation on perineum and cervix done December 15, 1909.

April 5, 1910, position good.

April 20, 1912, pregnant six months. Uterus and vagina has remained in good position.

CASE 7. P. D. Age 43. German. Occupation, housework. Admitted to hospital, January 15, 1909. Discharged March 15, 1909. Diagnosis: Prolapse of uterus.

Family history negative. Present history: One year before admission patient says she fell down stairs while carrying a hod of coal and the next day noticed a mass like a ball protruding from the vagina. The mass was not particularly sore or tender but would not remain when replaced in the vagina and has continued to get larger and larger up to present time. Patient has lost thirty-one pounds in the last four years, since husband's death, but attributes it somewhat to hard and unusual

work, as she was forced to support herself. Has had a good appetite all the time and states positively that she has had no discharge or pain.

General appearance. Poorly nourished woman of 43, of medium frame, mentality of rather low order. Eyes: Pupils equal, react sluggishly to light and accommodation. Mucous membranes fair condition. Tongue: Slightly coated. Throat and neck: Slightly hyperæmic and considerable enlargement of thyroid gland, especially right lobe is noticeable. Heart: Normal in size and position; no abnormal pulsations seen or murmurs heard. Arteries somewhat thickened. Pulse regular in rhythm and size; small; rate 80. Lungs, negative. Abdomen, wall very relaxed. Striæ prominent. No tenderness except on deep pressure on right lower quadrant, where small mass about size of lead pencil was felt. Liver, spleen, kidneys, negative. Skin harsh and dry. Bones, joints, muscles, negative. Lymph nodes, negative. Reflexes, slightly exaggerated. Sexual organs, see pelvic examination. Uterus: About normal in size and when patient lies down is situated low in vagina, but standing or straining, completely prolapses outside vulva.

*Operation.* Patient and field of operation prepared in usual manner. Incision made in mid-line between umbilicus and symphysis four inches long and peritoneum opened. Intestines walled off with gauze rolls. Uterus drawn up into abdominal wound. Peritoneum reflection from bladder incised and ureters on each side identified. Sutures of No. 6 plain catgut were then put from the pelvic fascia of each side outside the ureters, then drawing the fascia from each side together under the trigone of the bladder. About four of these sutures were introduced. The uterine arteries on each side and each infundibulo pelvic ligament were then ligated with No. 6 catgut and uterus cut free from vagina and broad ligaments. Opening in vagina was then closed with No. 4 plain catgut. Then utero-sacral ligament from right side was sutured to stump of broad ligament of left side and utero-sacral ligament of left side was sutured to base of broad ligament of right side, all uniting in one center over stump of vagina and under base of bladder. Peritoneum closed with No. 4 plain catgut, muscle sheath with same and skin with continuous silk suture. Dressing applied and patient returned to ward in fairly good condition.

CASE 8. C. S. Age 39. American. Occupation, housework. Admitted to hospital April 20, 1912. Discharged May 14, 1912. Diagnosis: Displacement of uterus. Complication.

Family history negative. Past history: Operated on at home in November, 1908, for laceration and prolapse of uterus. Personal history: Menstrual: Started at 15; always regular; lasts 4 to 5 days. Moderate daily flow; no pains. Last regular period April 1, 1912, to April 6, 1912. Marital: Married June 28, 1906. Two children, twins, born May 28, 1907. No miscarriages.

Present illness: Patient delivered of twins on May 28, 1907. Instruments used and patient badly torn. She was in bed for about a month. She was up only about three weeks when she noticed that her uterus began to come down and she began to have a discharge. This got gradually worse and she was operated on in November, 1908, and was all right until about July, 1909, when she noticed it coming down again; her discharge began to get troublesome again and it has been very troublesome ever since. Patient's uterus comes out immediately on getting on her feet or soon after and often swells so that she can hardly replace it. She has had irregular bladder symptoms since onset of present trouble. Bowels constipated. Very little backache or headaches. The vagina, base of bladder and uterus cannot be kept inside the pelvis, unless the patient is recumbent. Uterus and vagina are greatly hypertrophied, and drop wholly out when standing.

*Operation* April 23, 1912. The vagina was plicated from uterus to urethra. The greatly elongated utero-sacral folds and broad ligaments were shortened by bringing forward the lower half of the latter and the sacral fold of each conjointly, uniting them in front of uterus at vaginal junction, and fastening them there. This was accomplished by encircling the folds and the section of broad ligament with a suture, one for each side, tying them together in front, then stitching them down to underlying surface. The plicated fold in vagina was then opened from below, trimmed off, and surfaces coapted with catgut. Rectocele and perineum repaired at same time.

CASE 9. F. F. Age 53. Canadian. Occupation, nurse. Admitted to hospital November 14, 1911. Discharged December 18, 1911. Diagnosis: Prolapse of uterus.

General history: Patient is 53 years old; works as a professional nurse. Family history negative. Previous history: Habits good; no alcohol; appetite good; bowels constipated. Usual diseases of childhood. Venereal denied. Always healthy in adult life. Was operated on for alveolar abscess and antrum disease about one year ago. Menstrual history: Menopause at age of 50. Previous menstrual history negative. Obstetrical history negative.

Present illness: Had a rather acute onset. In April, 1911, patient walked the floor for about 20 minutes carrying a heavy, struggling child. The same evening she had lumbar backache and a bloody vaginal discharge. This discharge lasted for about a day, but the backache grew progressively worse. In addition she has had severe occipital headache, pain in the back of her thighs and a sensation of something dropping out below. After standing for a long time or straining at a stool patient says that something protrudes from vulval orifice.

Since onset patient has had frequency of urination, especially during the day, and burning after

the act. There is an intermittent, scant, thin, white, vaginal discharge.

Examination shows prolapse of uterus and vagina, the uterus can be drawn outside the vulva but when released about half of it returns.

General appearance: Thin, poorly developed and poorly nourished female of 53. Does not appear acutely ill. Abdomen: Soft; symmetrical; permits of deep palpation everywhere. No masses nor tendernesses made out. Liver, spleen, kidneys not palpable. Skin: Somewhat dry; no eruption; no œdema. Bones, joints, muscles, negative. Lymph nodes not enlarged. Reflexes present. Breasts poorly developed; firm; no secretions present. Uterus prolapsed second degree.

*Operation.* Patient prepared in usual manner. Incision four inches long in mid-line above pubis. Abdomen opened. Trendelenburg position. Incision through vesico-uterine peritoneum transversely. Bladder separated from anterior uterine and anterior vaginal wall by blunt dissection with periosteal elevator. Anterior vaginal wall plicated by transverse sutures catching one side of vagina, passing anteriorly and then taking in a bite of other lateral wall. Sutures tied. Clamp passed through broad ligaments grasping utero-sacral ligaments, drawing them anteriorly and fastening them to anterior surface of lower portion of uterus in region of cervix with kangaroo tendons. Round ligaments caught, drawn down and sutured to anterior surface of fundus of uterus with kangaroo tendons. Peritoneum not sutured over wound but allowed to drop in place. Abdominal wall closed in usual manner. Anterior vaginal fold slit up from cervix to urethral orifice and surfaces stitched together formed by sutures introduced in vaginal wall through laparotomy incision. Vagina packed with gauze. Retention catheter in bladder. Sterile dressing. To ward in good condition.

CASE 10. M. D. Age 42. Irish. Occupation, housework. Admitted to hospital September 22, 1910. Discharged November 19, 1910. Diagnosis: Prolapse of uterus. Complication: Old ventral hernia. Lacerated pelvic floor.

General history: Married. Five pregnancies. Venereal denied.

Present illness: Duration about one and one-half years. About one week after leaving Presbyterian Hospital patient felt burning sensation and a feeling as if something had given way in the left lower quadrant. Burning sensation was continuous. Three weeks later patient noticed small lump appearing between labia and this has gradually increased in size. Interferes with walking and makes urination difficult. Has increased frequency of urination. No burning or pain. Has to exert great force to start stream and cannot stop after she has once started. Bowels are always constipated.

Menstruation comes at intervals of six weeks; not painful; flow scant. Has constant sensation of something dragging or falling down about pelvis. No gastric disturbance; slight headache occasionally. No chills, fever or leucorrhœa. Uterus prolapsed. Operation same as preceding case.

CASE 11. E. G. Age 46. American. Occupation, chambermaid. Admitted to hospital October 10, 1910. Discharged December 3, 1910. Diagnosis: Prolapse of uterus. Complication: Lacerated perineum.

General history: Married. Four pregnancies.

Present illness: Duration about seven years. Patient says that off and on for seven years her womb would come down. She had peculiar sensation by which she could feel that it was down, and some times it would protrude outside vulval orifice and would go back into position itself without patient lying or sitting down or any manipulation. Had no pain but interfered with walking. While womb was prolapsed patient would have severe pain on urination. For past three weeks she says her womb has been down and protruding continuously, and patient could not sit down, and urination and defecation were extremely difficult and painful. Uterus prolapsed. Operation same as preceding case.

CASE 12. M. M. Age 50. German. Occupation, laundress. Admitted November 18, 1909. Discharged February 10, 1910. Diagnosis: Prolapse. Complication: Cystocele rectocele.

Family history negative.

Present history: For the last year patient has noticed that whenever she walked or went to stool her anterior vaginal wall would bulge down into the vulva. This is accompanied by severe pain along the sides of her abdomen and in her back. She has frequency of urination but no pain. She is troubled with almost constant frontal and occipital headache. Her bowels are very constipated and she becomes nauseated at the slightest cause; she does not vomit however. Patient feels very weak. Uterus prolapsed. Operation same as preceding case. Result, April 14, 1912, excellent.

CASE 13. E. H. Age 48. Irish. Occupation, housework. Admitted to hospital April 22, 1910. Discharged July 25, 1910. Diagnosis: Prolapse of uterus. Complication: Rectocele cystocele.

Family history negative.

Present history: Patient was operated on in this hospital and ward eight months ago, and about six weeks after leaving hospital, while at work, she says her womb came down and was put back with some difficulty. Whenever it is prolapsed she suffers from great pains in back, bearing down sensations, considerable pain and difficulty in urination. She has to wear a perineal support but gets little relief and as condition interferes with her work she came to hospital for cure. General health has been fairly good. Uterus prolapsed. Operation same as preceding case.

CASE 14. M. D. Age 38. German. Occupation, housework. Admitted to hospital April 25, 1910. Discharged May 6, 1910. Diagnosis: Prolapse of uterus.

Family history negative.

Present history: About three months after patient's last labor eighteen months ago, which terminated in an embryotomy, she began complaining of general ill health and dragging sensations in pelvis as if her insides were falling out. Consulted a doctor, who inserted a pessary and put her on douches. She expelled the pessary shortly after, but continued to treat herself with douches. Had no symptomatic disturbances and felt pretty well except for sensations of prolapse. About one month ago had cough and began to complain of severe dragging pains in back which have persisted. No vesical or rectal disturbances. No discharge.

Pelvic examination: External genitals: Very relaxed, otherwise negative. On coughing or straining vaginal walls roll out markedly and cervix presents at vaginal orifice. Perineum: Very relaxed, support poor; shows old laceration. Vagina: Ostium gapes, relaxed and roomy with marked degree of rectocele and cystocele; fornices negative. Cervix: Soft, movable, very low down and somewhat anterior. Os patulous. No tenderness. Uterus: Enlarged slightly; well back in pelvis; retroverted and prolapsed about second degree; consistency soft; symmetrical; no tenderness. Adnexa: Negative.

*Operation.* Polk's suprapubic operation on pelvic floor. Perineorrhaphy. Patient and field of operation prepared in the usual manner. Incision about four inches long median and ending one inch above symphysis. Abdomen opened and patient put in Trendelenburg position. Pelvis found to contain considerable adhesions about uterus and tubes. Uterus somewhat enlarged and softened and tubes the seat of recent inflammatory changes. Adhesions released. Incision through peritoneum over utero-vaginal junction and peritoneum retracted. Vaginal wall plicated by four kangaroo tendon sutures. Peritoneum closed by catgut sutures extending well up and including the approximation of the round ligaments in front of uterus. Closed ends of the tubes incised and opened. Peritoneum and fascial planes closed by catgut and skin by silkworm gut. Patient put in lithotomy position. Skin between anus and vagina incised and vagina dissected free. Incision goes to site of old fourchette. Lateral walls approximated by catgut suture. Skin closed by deep catgut sutures in antero posterior line. Patient dressed and returned to ward in good condition.

Last report, December, 1911, good result maintained.

Case 15. F. M. Age 40. American. Occupation, midwife. Admitted April 26, 1912. Diagnosis: Laceration of pelvic floor. Prolapse of uterus. Family history negative. Venereal denied.

Present illness: Patient comes to the hospital on account of the prolapse of her uterus. She says she was told that she was torn with her first child twenty-seven years ago, but nothing was done and she had no trouble afterwards or after her second child was born, which was twenty-one years ago. Five years after her second child (1896) she again became pregnant and then began to have such severe pains in her lower abdomen and felt so weak that she consulted a doctor, who told her that she had womb trouble from an old laceration and that she would abort. Patient carried the child for four months by taking very good care of herself and then aborted. Since that time if patient was on her feet much she would have severe pains in her sides and she would go to a doctor and have a tampon put in and rest up and would then be all right for six months or a year. At that time patient could feel the uterus at the opening of the vagina.

Patient has always been constipated and has been troubled with increased frequency of micturition for about ten years.

Patient has been taking a course in midwifery for past six months and had to be on her feet a great deal and all her symptoms have become exaggerated so she comes in for an operation. No pulmonary or cardiac symptoms. Has to get up once or twice a night to pass her water as a rule and has severe headaches at times. Sees spots before her eyes and feels dizzy at times. Chief complaints: 1. Prolapse of uterus. 2. Constipation and increased frequency of micturition. 3. Headaches and dizziness. Uterus prolapsed. Can be drawn two-thirds outside pelvis.

*Operation.* Repair upper pelvic floor. General anæsthesia. Dorsal position. Soap and water preparation. Bullet forceps attached to cervix per vagina. After opening the abdomen the vaginal and supervaginal supports put on stretch by traction on this forceps. Utero-sacral ligaments clearly outlined thereby were then shortened thus: Each seized, successively one inch from uterus, drawn through opening in broad ligament and attached to anterior lateral aspect of utero-vaginal junction. Opening in broad ligament made at inner lower angle of this structure; attachment made several loops of suture. Seizing anterior vaginal wall at utero-vaginal junction this structure put on stretch upward. Bladder separated from anterior face of vagina to trigone. Anterior vaginal wall slit open from utero-vaginal junction to trigone. Lateral walls of vagina approximated along mid-line covering in the incision. Round ligaments drawn inward and attached to sides of uterus at utero-vaginal junction. Abdomen then closed. Gauze dressing. From below the apposed surfaces of anterior vaginal wall below line of sutures put in from above were then apposed from above downward from uterus to tongue. Repairs of perineum left for future operation. Patient left hospital without repair of perineum.

Case 16. A. F. British West. Age 40. Occupation, housework. Admitted February 16, 1912. Discharged March 10, 1912. Diagnosis: Complete procidentia. Complication: Prolapse of uterus.

Family history negative.

Present illness: Patient's trouble dates back to the birth of her last child in June, 1907. She was delivered with instruments and she thinks she was

torn. No operation was done. Patient was in bed only about ten days and then got up and did her work as usual. Patient was apparently all right for about two years, when she began to have a discharge and not long after she noticed that her "womb was falling." This has slowly and progressively gotten worse until now her uterus comes all the way out. The discharge has gotten worse until at present it is profuse in amount and very foul smelling and is yellow in color. Patient has never had much pain until the last year, when she noticed that if she was on her feet much she would have heavy dragging pain in her back and sides and also headaches. When she gets tired this way it becomes very painful to pass her water. When she pushes her uterus back there is no more pain and she can pass her water easily.

Bowels always constipated. Patient has noticed a little blood in her vaginal discharge for past three or four months and it is increasing in amount. Patient does not think she has lost any weight. Appetite always good. No cardiac, renal or pulmonary symptoms. Chief complaints: 1. "Falling of her womb." 2. Headaches and backaches if on feet for any time. 3. Vaginal discharge. Sexual organs: Uterus can be drawn outside pelvis.

*Operation.* Repair upper pelvic floor. General anæsthesia. Dorsal position. Soap and water preparation. Bullet forceps attached to cervix per vagina. After opening the abdomen the vaginal and infra-vaginal supports put on stretch by traction on this forceps. Utero-sacral ligaments clearly outlined thereby were then shortened thus: Each seized successively, one inch from uterus, drawn through opening in broad ligament and attached to anterior lateral aspect of utero-vaginal junction. Opening in broad ligament made at inner lower angle of this structure. Attachment made several loops of suture.

Seizing anterior vaginal wall at utero-vaginal junction this structure put on a stretch upward. Bladder separated from anterior face of vagina to trigone. Anterior vaginal wall slit open from utero-vaginal junction to trigone. Lateral walls of vagina approximated along mid-line covering in incision. Round ligaments drawn inward and attached to sides of uterus at utero-vaginal junction. Abdomen then closed. Gauze dressing. From below: The apposed surfaces of anterior vaginal wall below line of sutures put in from above were then apposed from above downward from uterus to trigone. Repair of perineum left for future operation.

CASE 17. M. O'B. Age 48. Irish. Occupation, waitress. Admitted March 25, 1912. Discharged April 17, 1912. Diagnosis: Displacement of uterus. Retroversion.

Family history: Mother, father and one brother dead. Causes unknown.

Present illness: Patient went to the dispensary because she had "falling of womb." Patient first noticed her womb coming out about three years ago. It did not come all the way out then, but it has gradually come further out until it comes out two or three inches now. It goes back in when she lies down. Patient denies any discharge or any bladder symptoms. She has had bearing down pains in her back since she first noticed that her womb was falling. These are worse now than ever before and are worse when she is walking or working on her feet, being relieved by lying down. Bowels constipated. Chief complaints: 1. Falling of womb. 2. Dragging pain in back.

General appearance: Sparely nourished; medium statue; dorsal posture; no pain. External movements; eyes normal; pupils equal and react normally. Mucous membrances good color; no patches; tongue clean; throat clear. Heart: No abnormal neck or pericardial pulsation or thrills. P. M. I. Fifth interspace, third left mid-sternal line on ausc. Area C. dullness, not enlarged. Sounds at apex and base clear. Pulse: Regular in force and rhythm; volume full; tension moderate; v. w. slightly thickened. Lungs: Chest fairly well formed, symmetrical, expansion poor. Fremitus normal, percussion and auscultation negative. Abdomen: Rather sunken but natural contour. No local tenderness or rigidity. No masses. Liver, spleen, kidneys not enlarged; not palpable. Skin: Scars on face and right knee of old accident. Bones, joints, etc., normal. Lymph nodes not enlarged. Reflexes normal. Sexual organs not examined.

April 1. Patient operated on by Barrows. See operation sheet. She took ether well and made a good recovery. April 2. Patient in fair condition. She is getting saline per rectum q. 4 h. has had some vomiting. Pulse fair. April 3. Patient is suffering some pain in abdomen. General condition fairly good. Vaginal packing removed. Patient has no complaints. Pulse good. Tongue clean and moist. Quite comfortable. April 4. Condition good. No complaints.

*Operation.* General anæsthesia. Dorsal position. Soap and water preparation. Abdomen opened by usual median incision. A ventral fixation had been done at a previous operation. The uterus had elongated to about eight inches and was about the diameter of a thumb of medium size. The broad ligament was thinned out and the tubes and ovaries were in a position almost parallel to body of uterus. The uterus was cut free and the bladder separated from the anterior surface of the uterus. The utero-sacral ligaments were brought to the utero-vaginal juncture and attached there and the broad ligaments shortened with kangaroo tendon sutures. Abdomen closed. Patient put in dorsal lithotomy position and cystocele repaired. Gauze dressings.

In ending this paper I cannot forbear calling your attention to the advantages to be derived in cases of retroversion of the uterus which cannot be cured in any other manner except by operation. It is well known that a

large number of these cases are without symptoms and therefore need no operation. Others can be cured by simply reducing the size of the uterus through curettage and packing; in other words bringing about involution and supporting the organ temporarily with a pessary. There are other cases, however, which even though treated by the Alexander operation, or any of its modifications, or by ventral fixation, relapse, carrying with them their symptoms of discomfort and even incapacitate nervous and susceptible women. These relapsing cases I believe fail largely through defects in the peritoneal surface of the pelvic floor. Coffey of Portland has suggested an operation which to my mind comes nearer meeting this defect than any other I know of. The transference of the traction about the base line of the uterus to the front, as suggested in this operation for procidentia, has in it, I believe, elements which meet the basic principles required to correct this defect. Separation of the bladder has no place here but narrowing plication of the vagina opposite the cervix, with, or without conjoined shortening of the utero-sacral broad and round ligaments, has something in it worthy of further inquiry.

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## SLIDING HERNIA[1]

By PAUL F. MORF, M. D., Chicago

ALTHOUGH sliding hernias have been known for a long time, having been described by Scarpa in the early part of the nineteenth century, the subject has attracted comparatively little attention in English and German medical literature. Among French surgeons, on the contrary, there has been a lively interest in this variety of hernia, and the French medical literature contains many able papers describing the anatomy, pathology and mechanism of development and treatment of the *hernie par glissement.*

My own attention was attracted to sliding hernias a number of years ago by a case that came under my care in 1899. The history is briefly as follows:

The patient, a woman aged 53 years, had a right inguinal hernia about as large as a cocoanut which had descended into the right labium majus. This hernia had been present for many years, had gradually increased in size, and had been irreducible for a long time, although the accident of strangulation had never occurred. No truss could be worn on account of the discomfort which it occasioned. On the left side was a smaller inguinal hernia about as large as a small orange, which could readily be returned to the abdominal cavity. The patient was operated for the radical cure of the hernias. On the right side a large sac was found which contained numerous coils of the small intestine. At the upper and outer part of the sac the cæcum and about four inches of the adjacent portion of the ascending colon were found, forming an integral part of the sac. Careful examination of the anatomical relations revealed the fact that this part of the colon, namely, the caput coli and adjacent four inches of the colon, had slipped down into the hernia together with the layers of peritoneum which normally attached it to the iliac fossa and posterior abdominal wall.

Besides this case I have come across two additional cases on both of which I operated during the last six months at the Cook County Hospital. The first of these was also a hernia of the cæcum and lower colon found in a right inguinal hernia in a man. The last case was a small oblique inguinal hernia on the left side, which had existed for over twenty years in a man accustomed to perform heavy work. It was about as large as a walnut, irreducible, and had not increased appreciably in size for many years although

[1] Read before the Chicago Surgical Society, December, 1911. (See discussion on p. 351)

no truss had been worn. In this case a small knuckle of the large intestine together with its investing peritoneum had migrated into the inguinal canal. The firm attachment of the gut to the peritoneum, and the adhesion of the latter and of the gut to the underlying connective tissue, precluded the reduction of the hernia and also no doubt prevented the enlargement of the rupture in spite of the fact that no truss had ever been worn.

*Hernie par glissement*, as it is denominated by the French authors, or *Gleitbruch*, the German term, according to Scarpa, designates a condition where "the intestine glides in the connective tissue of the lumbo-iliac region behind the peritoneum, separating the latter by its passage, and in this way arrives at the fold of the groin where it may enter the hernial tract, drawing with it an incomplete peritoneal investment." This definition therefore excludes herniated portions of the large intestine which have a complete peritoneal investment such as the cæcum or transverse colon. The essential feature is that the herniated gut has an incomplete peritoneal covering, the uncovered part being adherent to the adjacent connective tissue, and the herniated gut taking part in the formation of the sac. The sigmoid, which in part of its extent has a complete peritoneal investment, may form a sliding hernia if the peritoneal attachment to the abdominal parietes gravitates into the hernial tract and along this outside of the abdominal cavity.

The frequency of this form of hernia has not been fully established. An idea of its occurrence however may be gained from the report of Judd from the Mayo clinic. Among 1,652 operations for the radical cure of inguinal hernia performed at St. Mary's Hospital there were 14 sliding hernias. Sprengel of Braunschweig found 13 instances among 800 hernias operated upon. Baumgartner collected 159 cases from the literature. It is evident from these figures that the condition is not uncommon, but additional statistics from other clinics would be of great value in determining its exact relative frequency. As to location Judd reports 8 on the left side involving the sigmoid and 6 of the cæcum and ascending colon on the right side. Baumgartner (cited by Sprengel) found 85 to be right inguinal hernias containing portions of the ascending colon and 63 left inguinal hernias containing parts of the iliac and pelvic colon. In seven instances parts of the large intestine were found in crural hernias, and in 4 cases the cæcum was found herniated through the inguinal canal on the left side. Almost invariably the hernia is of the oblique variety; only two cases in Baumgartner's series were direct.

The mechanism by which this interesting pathologic condition develops is of interest. It appears that the large intestine together with its peritoneal associations may enter the hernia primarily by sliding down into the hernial tract. Whether this is due to pressure exerted from above or to an abnormally loose texture of the connective tissue to which the intestine is normally attached, or to some other condition, has not been satisfactorily established. It has been suggested that the alternate filling and emptying of the gut may gradually cause a relaxation and separation of the peritoneal folds, thus giving favorable conditions for the sliding down of the intestine. This phase of the subject demands further study and investigation. The relaxation of peritoneal folds may possibly be partially accountable for that rare form of sliding hernias which the French authors have classed under the term *hernie par bascule*, the Germans under the name of *Schaukelbruch*. In this variety the first part of the hernia to be displaced is the ascending colon while the cæcum and appendix retain their normal habitat in the ileo-cæcal fossa. The ascending colon above the cæcum slides by the caput coli and vermiform appendix, which are retained in the ileo-cæcal fossa by their stronger peritoneal folds or ligaments, while the more loosely attached colon is not held in place by its peritoneum which has been relaxed and stretched. Besides this primary sliding hernia it seems that the condition may often be secondary. In this case there probably originally exists a hernia of the small intestine. As more and more coils of the small intestine are forced into the sac the latter becomes enlarged, drawing on the peritoneum of the postero-abdom-

inal wall for its supply. By this means the cæcum and ascending colon can easily, in the course of time, be drawn down through the hernial canal and these organs finally come to lie far from their original location. This mechanism applies especially to hernias of the cæcum and adjoining portion of the ascending colon and appears to me to have been the manner of development of my first case. On the other hand it is readily conceivable that a hernia of the sigmoid with its mesentery may at first resemble exactly a hernia of the small intestine, but that in the course of time the weight of this organ will exert sufficient traction on its peritoneal attachments and the subjacent connective tissue to transplant them to a point far distant from their primary location.

From these considerations it becomes evident that in a true sliding hernia we have to deal with one in which the sac is incomplete, a part of this structure being formed by the herniated organ. That this is of considerable importance may be realized when we recall the disposition of the blood vessels which supply the herniated gut. As the intestine slides downward into the canal through which it leaves the abdominal cavity it takes with it its arterial and venous blood supply and its lymphatics in a manner analogous to that of the testicle in its descent from the abdominal cavity into the scrotum. These vessels are drawn out and stretched, and lie in the connective tissue of the hernial tract. Any careless attempt made to free the intestine from its connective tissue attachment may be followed by grave consequences, as an injury to the blood vessels may interfere with the blood supply and so compromise the integrity of the gut. A careless attempt at opening the sac may also be dangerous, especially to that form of hernia that the older authors classified under hernias without a sac. If, while operating, the incision happens to lie over that part of the gut which forms part of the sac, it is easy to see that as the dissection goes through the successive hernial coverings and no sac is found, the operator, if not aware of the true condition, may open the gut itself. Such an accident, while not a dangerous eventuality, is, to say the least, extremely undesirable in these days when we count with certainty on the primary healing of all hernia operations. The extent to which the sac may be deficient is subject to variation from the form in which none or almost none is present (*hernie par bascule*), to the form where a large sac exists and the herniated intestine is inserted in one of its walls with or without a meso. The difference is only one of degree. The extent of completeness or incompleteness, according to Albert de Mayo (cited by Sprengel), probably depends upon the amount of peritoneum drawn from the anterior and posterior abdominal wall. If more is drawn from the anterior abdominal wall, the sac will be more nearly complete, while if the larger portion is developed from the posterior parietal layers the sac will be small.

*Symptoms and diagnosis.* There are few signs and symptoms that are characteristic of *hernie par glissement.* In the majority of reported cases the diagnosis has been made on the operating table during the course of operation for the radical cure, or for strangulation, and has often times been an unexpected and exasperating complication. Nevertheless there are a few points which if given due consideration may occasionally give an indication that a sliding hernia exists. All hernias of the large intestine should be examined with this eventuality kept in mind. Also all irreducible hernias that have existed for a long time, especially if large and in old persons, should be regarded with suspicion, especially if a part of such a hernia is reducible while the irreducible portion is nodular and doughy in consistency. The epiploic appendices should give a nodular outline to the herniated gut which will differentiate it from the small intestine, but of course not from a herniated great omentum. Inflation of the colon with air should increase the volume of the part involved in the hernia, and filling it with water per rectum should change the percussion note from tympany to dullness. The suggestion of filling the colon with a bismuth suspension and afterwards having an X-ray plate made has been made, but to my knowledge this suggestion has not been acted upon up to the present time. Having estab-

lished the fact that a hernia of the large intestine exists and that this part of the colon is irreducible the supposition that a sliding hernia may exist is not far fetched. However, I believe we must agree with Sprengel when he says that with this variety of hernia we are in a similar position to that which we occupy in reference to hernias of the bladder. As in hernias of the bladder so here also there are certain symptoms which when taken into account may lead one in the right direction, even before operation is undertaken; but it is excusable considering the frequency of radical herniotomy at the present time, if each patient is not examined for these symptoms. A proper appreciation, for example, of the physical findings in my third case, that of a man doing heavy manual labor, where the small irreducible hernia had existed for many years without increasing materially in size, although no truss was worn, should have at least made a tentative diagnosis of sliding hernia possible.

Among the complications supervening in this variety of hernia, the occurrence of appendicitis in the herniated appendix which has accompanied the cæcum will at once suggest itself. The symptoms should not differ much from a similar accident in the normally situated appendix, except that the location of the inflammatory process is changed. This may lead one to think that a strangulation of the bowel has occurred, a mistake that will lead to no bad results, as prompt operative intervention will be necessary. The frequent accident of strangulation may also occur. It has happened that in a sliding hernia of the large intestine, the accompanying coils of small intestine have become strangulated, while the large intestine which had a different blood supply has remained normal.

Stercoraceous incarceration, when the sigmoid is the herniated organ, is also to be considered.

*Treatment.* As these hernias cannot be reduced completely they are not adapted for treatment by truss, and consequently often come to the surgeon for operation. Owing to the anatomic peculiarities the usual method of operation most suffer deviation after the preliminary steps leading to the uncovering of the sac have been taken. If the correct diagnosis has been made previous to operating, Sprengel suggests that the primary incision be made as far to the median line as possible in order to come upon the free part of the sac, which usually is present even if represented only by a small funnel-shaped process. In one of his cases this part could be found only with great difficulty and it was necessary after widely splitting the fibres of the aponeurosis of the external oblique to draw up the internal oblique, and after opening the free peritoneum in this location, to enter the peritoneal funnel from the abdomen.

The further operative steps must depend on the pathologic anatomy found in each individual case. If the adhesions between the gut and the subjacent connective tissue are not too firm and intimate, this structure may be raised up, together with its peritoneal folds, and pushed back into the abdominal cavity without interfering with the blood supply. If the herniated portion is not large and this procedure is possible, it is most advantageous and the operation may be quickly concluded. I was able to do this in my three cases. The part of the sac formed by peritoneum drawn from the anterior abdominal wall was cut away close to the internal abdominal ring and intestine, and the opening closed by catgut sutures. It seems to me that a good plan to follow would be to close off the sac as close as possible to the intestine and ring by a row of through and through catgut sutures, then instead of cutting it off as is usually done, if sufficient material is present, it might be drawn downward and outward and sutured to Poupart's ligament below and external to the portion of the replaced gut, thus giving some, though perhaps little, support.

Hartmann has advised after resecting the useless part of the sac, that it be sutured and the pedicle fixed as high as possible to the abdominal wall, analogous to the procedure of Barker. This method while forming a new ligament for the intestine has its inconvenience. Berger (Le Dentu and Delbe's Surgery) reports a case of fatal occlusion of the intestine following this maneuver, the

high fixation having caused an acute kinking of the intestine.

If the proper planes of cleavage between the intestine and connective tissue are found the former can be returned to the abdominal cavity in the manner just described. In old and inflamed hernias this unfortunately is sometimes difficult or impossible. The suggestion has been made that in such cases the abdomen should be opened and the peritoneal layers separated from above. But, even so, separation from the underlying connective tissue will not always be possible without sacrificing the integrity of the vascular supply with its untoward consequences. In several cases Sprengel found the adhesions to the structures of the spermatic cord so intimate that he was forced to sacrifice the testicle owing to the injury of the blood supply of this organ, resulting from the separation of these adhesions.

When the adhesions are so firm and numerous that they cannot be separated without compromising the blood supply of the herniated gut, two ways are open. Either the operation must be abandoned or the intestine must be resected, either alternative being unsatisfactory but unavoidable. Of the two it would seem to me that resection of the gut should be favored, provided that the general condition of the patient is such that he is able to bear a prolonged operation.

These procedures should be sufficient if the herniated portion of gut is small. If, as sometimes happens, a large knuckle of intestine has left the abdominal cavity, the simple pushing back of the gut is insufficient. A speedy recurrence of the hernia may be expected with certainty, because the portion of the intestine so replaced will be without any adequate abdominal attachment and naturally come to lie and press upon the weak portion of the abdominal wall where the original migration took place. To overcome this difficulty in one case Morestin, after separating the intestine, performed a laparotomy through the oblique abdominal muscles, drew up the herniated gut and fixed it in position by suturing the peritoneal leaflets to the abdominal wall. The procedure of Savariaud has also been followed. This consists in folding back the herniated intestine between the separated layers of peritoneum, applying these to each other by suture and in this manner reconstructing the mesentery.

# DEPARTMENT OF TECHNIQUE

## THE SURGICAL TREATMENT OF PUERPERAL SEPSIS

By WILLIAM EDGAR DARNALL, A. M., M. D., Atlantic City, New Jersey
Gynecologist to the Atlantic City Hospital

THE high mortality which attends the severe forms of puerperal sepsis has induced many efforts to save life by operative measures. It is difficult to lay down positive rules for guidance, and exceptionally good judgment and wide experience may be required to make the right decision in a given case as to when to operate and when not to do so.

There are some forms of infection in which it may be advisable to explore the uterus to ascertain its condition. If the abdominal examination has shown an organ with delayed involution and tenderness, and if the lochia is beginning to be foul, this would suggest the retention of blood coagula or the products of conception. If an exploration is to be made, it should be done only under the strictest aseptic precautions. The vulva and vaginal walls should be thoroughly disinfected, and in order to make an evacuation of the contents of the uterus thorough anæsthesia is usually necessary. The whole cavity of the uterus can thus be investigated by the finger, which should be gloved. Under normal conditions the surface of the uterus should feel smooth except at the site of the attachment of the placenta. This can be identified as a roughened and irregular area projecting slightly above the surface. If there is placenta present it may be recognized as a mass projecting into the uterine cavity and may be separated by using the finger as a curette. After all loose fragments have been thus separated and removed the surface of the uterus may be gently rubbed with cotton or wool on an applicator or swabbed with the tincture of iodine.

The curette should be reserved only for those cases in which the retained products cannot be effectually removed by the finger or douche. There is no doubt that it is sometimes useful in skilled hands in emptying the uterus, but its dangers are so great that in the hands of the average practitioner it should rarely be used in the puerperal uterus. In spite of the repeated warnings of those most experienced in its use, who use it with fear and hesitation, every tyro is confident that he can employ it with boldness and skill and hesitates not "to rush in where angels fear to tread." It is a fact that nearly all those very serious cases that come into the hospital in critical condition give a history of having been curetted one or more times by the attendant. The curette must, in any puerperal case, be used with the greatest skill and judgment. If the lochia is scanty or purulent and evidence of retained products is not present, then the operation is contra-indicated. If the uterine cavity presents a smooth surface, as it does in many cases of severe streptococcic infection, then a curettement is probably the worst thing that can be done, as far as the patient is concerned, and it should be absolutely forbidden. It is in these cases that the most harm will be done by its use and the result may prove fatal to the patient. It is not to be denied that in some cases where fever follows delivery there is a prompt subsidence of the symptoms following curettement, but these cases are almost always cases of sapremia and would terminate favorably spontaneously, or under other treatment.

The time for action is on the first rise of temperature after delivery. A thorough examination externally and internally of the pelvic organs should be made. If it is determined that the uterus is not entirely emptied and all clots, decidua and debris cannot be removed by the finger, then a large broad curette such as that used by B. C. Hirst may be gently passed over the surface of the uterus with just enough force to dislodge scraps of retained products. Such a curette will remove the debris effectively without injuring the mucosa. The ordinary sharp Simms curette should never be used under any circumstances.

Whatever manipulation is adopted should be done in the very beginning of the trouble. After infective organisms have penetrated the body of the uterus or have spread to the lymphatics, or if general infection has taken place, then any local

treatment by curetting is as useless as trying to remove sand from the beach by sweeping it up, and is often productive of the greatest harm to the patient.

An important distinction must be made, however, between infection occurring as a result of abortion in the early months of pregnancy and infection after labor at or near full term. After abortion in the early months the results of curettement are almost invariably favorable if done at once, whereas after labor at or near the full term it becomes a very dangerous instrument. It is more injurious than useful, and instead of being used indiscriminately by everybody should be reserved as almost a last resort and used only after most mature deliberation.

Suppuration in the pelvis may be the result of inflammation of the pelvic cellular tissues after childbirth, or may arise from peritoneal infection either with or without the formation of pus in the appendages. The attempts which have been made to cut short the course of a pelvic cellulitis by early free incision and drainage have not given very satisfactory results. It must not be forgotten that in the absence of pus formation, large masses of exudate may be absorbed. It is therefore to my mind inadvisable to undertake any operative procedures unless there is definite evidence of the formation of pus. If there are the clinical symptoms of pus formation and the abscess forms in the upper part of the broad ligament an incision may be made in the abdominal wall parallel to Poupart's ligament. The abscess may in this way be evacuated without entering the peritoneal cavity. If the abscess, however, fills the most dependent part of the pelvic cavity, namely, the pouch of Douglas, then an incision through the posterior vaginal wall may be made and the pus readily evacuated.

The formation of pyosalpinx in the course of puerperal infection is rare. If it exists it is usually the result of a pre-existing gonorrhœa. An infected tube, however, may have existed before the pregnancy occurred. I have frequently observed a run of temperature, an elevated pulse, and other symptoms of puerperal infection which were due to an old pus tube. The onset of labor in these cases has seemed to light up an old fire which had been smouldering in a chronic or subacute stage.

The extension of the infective process from a puerperal uterus usually follows the line of the lymphatics, producing abscess in the ovary or the pelvic cellular tissue. The pus in cases occurring in this way after delivery is of a very virulent type, and if peritonitis of a diffuse kind takes place it is rapidly fatal. To attempt therefore to remove appendages thus infected through an abdominal incision is to invite grave risk of setting up a diffuse peritonitis. If the infection happen to be from the streptococcus the danger is particularly great. The wisest course therefore if the presence of pus is detected in the pelvis after childbirth, is to perform a posterior colpotomy and drain the pus from below. In those subacute cases in which there is no immediate danger to life, experience has taught that the avoidance of all operative treatment is the best course to pursue, until the virulence of the pus is attenuated and the acute stage is passed. Then treatment should be instituted by abdominal section if the appendages are infected, or by posterior colpotomy in the case of a pelvic abscess.

Puerperal peritonitis is a dangerous complication and the mortality has always been high. The adoption of surgical procedures in the last few years has been attended with quite a degree of success, but there is no question connected with childbirth which demands more careful judgment than the question of surgery in some forms of puerperal peritonitis. It is not probable that the results will ever be so favorable as those obtained from peritonitis due to some local lesion such as appendicitis, perforating ulcers of the stomach, intestine, gall bladder, etc. This is true because it is rarely possible to completely remove the cause of the infection as is done in these cases.

The flat-bellied peritonitis due to a severe and virulent streptococcic infection in which there is no peritoneal reaction is dreaded by every surgeon. There may be subnormal temperature, cold, leaky skin, no pain, or very little, and the coils of intestine are found to be united by a fibrinous or purulent lymph. Death always ensues in these cases, which may last three or four days. They are quite beyond surgical or any other kind of treatment, and seem to be overwhelmed from the beginning with the toxæmia.

If the peritoneal infection is limited to the pelvis then posterior vaginal section should be done promptly and thus check its spread. This is especially valuable in the early stage of lymphatic peritonitis spreading from the uterus and broad ligaments. It should never be done in the diffuse forms of peritonitis because it is entirely too inadequate to meet the grave conditions present .

Great difficulty may be presented in the early diagnosis of general puerperal peritonitis. If an operation is to be done at all, it should be done early if a favorable outcome is to be gained. If

we wait until the disease has fully developed valuable time will be lost and the operation may be undertaken too late to save life. On the other hand, we know that many cases which look very bad at first subside spontaneously and the symptoms clear up. It is manifestly unjustifiable therefore to open the abdomen of every case on the first appearance of symptoms of peritonitis. Wide experience and good judgment are the only rules for guidance under such circumstances.

Very frequently, the symptoms of peritonitis develop gradually and a variable amount of sero-purulent fluid is poured out. These are usually the less virulent cases, and abdominal section followed by the Murphy drip and the Fowler position saves many lives. In some instances localized collections of pus occur, being especially liable to form around the appendages, the pouch of Douglas or in the iliac fossa. The results obtained here by incision and drainage are good.

In diffuse peritonitis abdominal section is the operation of choice, for it has the advantage of permitting a complete exploration of the whole abdominal cavity. Sometimes unexpected conditions may be discovered as the cause of the infection which had hitherto escaped detection, such as ruptured appendix, tumor of the uterus or diseases of the appendages. Drainage should preferably be through the vaginal vault, though in some cases drainage may be put through the abdominal incision also or a stab wound. The best results will be obtained by a simple irrigation with normal salt solution at a temperature of 100° F., avoiding, as far as possible, any handling or manipulation of the tissues, and not attempting to detach flakes of lymph as was formerly done, for these are a part of nature's own protective.

The remarkable success obtained in the treatment of aural pyæmia by ligature and excision of the jugular vein has stimulated attempts to carry out similar modes of treatment in pelvic thrombo-phlebitis. Trendelenburg in 1902 removed septic thrombosed veins for the relief of puerperal infection. Successful operations of this kind have been also reported by Williams, Freund, Bumm, Vineberg, and Seligmann.

The diagnosis of thrombo-phlebitis is not attended with particular difficulty. Repeated rigors form a characteristic feature in almost all cases, though occasionally they are absent. Trendelenburgh, Bucura, and others advise operation after the third or fourth rigor. Lea thinks this a little early, in view of the fact that about forty per cent of the cases will get well spontaneously. The mortality is high. Forty cases, including five of his own, were analyzed by Whitridge Williams, showing a mortality of 43.9 per cent. The best results have been obtained in the subacute or chronic cases operated upon four to six weeks after delivery. There is little doubt that a considerable number of such cases would get well without any operation. It is not possible up to the present time to formulate precise indications for the operation, and owing to its gravity it is not probable that it will be adopted by the profession generally.

Hirst says: "If abdominal section is done because thrombo-phlebitis is suspected many an unnecessary operation will be done. I have very rarely indeed seen a condition of the ovarian veins that called for their ligation or removal. Thrombo-phlebitis as the sole cause of an operation and as the only thing to be removed is not yet demonstrated to the majority of surgeons." Polak believes that thrombo-phlebitis is a conservative process on the part of nature to limit infection and that any form of pelvic manipulation only tends to break down and separate parts of these thrombi, extending the infection to the more remote parts, thus jeopardizing the patient's life.

The question of the removal of the uterus as a mode of treatment in certain cases of puerperal infection is one that is attended with some difficulty. If there have been extensive injuries to the uterus, such as a rupture or a perforation, or if there is an infected tumor such as a myoma, or if an abscess of the uterine wall can be diagnosed, the operation is clearly indicated. If the operation is performed simply in the hope that a fatal result from septicæmia may be averted, it is very much open to question. It is difficult or impossible to recognize the moment when it can be said that the infection is confined to the uterus. If it has gone farther than the uterus the operation cannot remove all the infection. If it is delayed until infection is established it may be too late. and will only precipitate the fatal issue. If done early we only subject the patient to the risks of a grave operation, and in many cases she would have recovered spontaneously anyhow. There is the further danger of conveying infection to the peritoneal cavity, or of opening up fresh lymphatic spaces and the fresh wound surfaces may readily become a source of renewed infection. The mortality where hysterectomy has been done in puerperal cases has reached about 70 per cent. This is considerably higher than the death rate from puerperal infection of severe types treated without operation.

Vaginal hysterectomy has been championed as being less liable to general infection and accompanied with less shock. This, however, has obvious disadvantages. The enlarged uterus is friable and more subject to lacerations. On account of the infiltration of the broad ligaments the danger from hæmorrhage is greater and it is harder to make a thorough exploration of the pelvic and abdominal cavities. It may be of use sometimes in cases of septic abortions or the later stages of the puerperium, but the method on account of its difficulties has largely been given up.

It is probable that puerperal infection has occurred as long as children have been born, but while great advances have been made in our knowledge of it, and its treatment, there are yet many problems which are not entirely settled. The temptation and the tendency is to do too much rather than too little. Unless it can be demonstrated that there are retained products of conception in the uterus, let the curette and intra-uterine douche alone. Local interference with the uterus otherwise can do no good and does result in a great deal of harm. Operative interference is not indicated unless a localized focus of pus can be demonstrated in the pelvis, or diffuse general peritonitis has taken place.

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# A METHOD OF ILEOSIGMOIDOSTOMY WITH THE FORMATION OF A SIGMOID VALVE

By ERNEST A. HALL, M. D., L. R. C. P. (Edin.), Vancouver, British Columbia

A THERAPEUTIC factor of unlimited promise — the drainage of Metchnikoff's "cesspool of the system"—has come to stay. From obstinate constipation, for the treatment of which Lane of Grey's hospital has done so much to popularize this operation, the writer has extended it to nephritis, ascites, osteo-arthritis and melancholia with results so far exceeding his expectations that he fancies in this procedure the highway of hope has been opened out to all conditions dependent upon intestinal auto-toxicosis.

The following technique has been used in a sufficient number of recent cases to justify the placing of the method before the profession.

Incision one-half inch to right of median line; the whole of viscera examined and abnormalities, if any, dealt with. Be sure the colon has been thoroughly cleared of fœces, the sigmoid free from adhesions and the rectum from stricture. In a great many cases the upper sigmoid curve will be found lying in contact with the terminal part of the ileum. These are the parts to unite, and

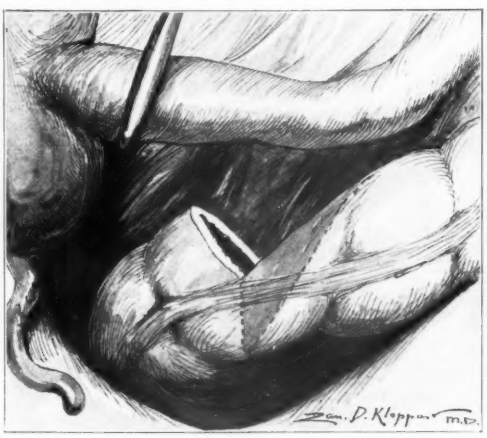

Fig. 1. Ileum at point of section, and sigmoid enfolded for purpose of valve.

Fig. 2. Anastomosis complete.

usually accommodate each other as well as the posterior surface of the stomach and the first part of the jejunum.

OPERATION.

1. Locate these parts, pack them off with gauze, clamp the ileum one and one half inches from the valve. Pass a linen purse-string suture around the ileum beyond the clamp, cut and invert the distal end and separate the mesentery for about one third of an inch of the proximal end.

2. Clear fat from the upper surface of sigmoid for a space of two inches, clamp above and below. Cut sigmoid transversely for about two fifths of its circumference, beginning at the upper border of the well defined anterior longitudinal muscle; with linen suture approximate the extremities of this incision, infolding the proximate flap within the bowel and suturing the surfaces for about one and one half inches, thus forming a sigmoid "valve." The distal flap following the contour of the bowel makes a lateral oval opening about the size of the ileum. If necessary this opening can be enlarged by a longitudinal slit. A small opening two inches lower in the sigmoid admits a clamp which is placed upon the ileum as the former clamp is withdrawn, and the bowel drawn within the sigmoid. The points of apposition being secured by forceps, a catgut suture is sufficiently deeply placed to control hæmorrhage, a musculo-peritoneal suture of linen follows, continued along the ileo-sigmoid surface for an inch or two to limit tension upon the anastomosed parts. The withdrawal of clamps and closure of the small incision complete the operation.

A careful toilet is made and the abdomen closed without drainage. Some sloughing of the free end of the ileum is expected, but not of the "valve," since the circulation has been little interfered with. The efficacy of this procedure to prevent fœcal accumulation as a result of retroperistalsis has yet to be proved.

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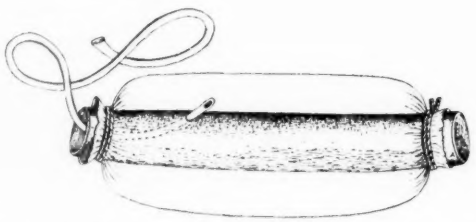
## AN IMPROVEMENT TO THE DRAINAGE TUBE AND INFLATED RUBBER BAG ARRANGEMENT FOR LIVER HÆMOSTASIS, AND AN ACKNOWLEDGMENT OF PRIORITY

By J. R. McDILL, M. D., Milwaukee, Wisconsin

THIS device, which I find was originated by Dr. Wm. E. Schroeder of Chicago in 1900 (see page 58, Vol. 11, 1906, SURGERY, GYNECOLOGY AND OBSTETRICS), I also described in an article in the November, 1911, number of this magazine. Instead of attaching the tube used for inflation to the side of the bag through an opening in its wall, which makes a weak spot, a small, firm red rubber catheter can be passed through the wall of the large rubber drain from its lumen outward, leaving the end within the bag. To avoid occlusion of the catheter from constriction by the puncture it may be necessary to take away a bit of the rubber where punctured or to burn a hole that will be small enough to hold the catheter firmly without obstructing it and at the same time snugly enough to prevent the escape of the air. This apparatus might also be used to advantage for wounds of excisions of a portion of the surface of the liver



instead of gauze, after the idea of Kousnetzoff and Penski, who in 1894 recommended a continuous suture over gauze packing below for such wounds. If a styptic is desired the bag can be smeared with a thick acacia gum in which the equivalent of a 2 per cent Lugol's solution is incorporated. On account of the softening effect on rubber the vaselines and oils must be avoided, and, though soap is always available, it might prove poisonous to the heart.

# THE RESULTS OF THE ROUTINE TREATMENT OF STRUCTURAL LATERAL CURVATURE BY MEANS OF PLASTER JACKETS[1]

By JAMES WARREN SEVER, M. D., Boston
Junior Assistant Surgeon, The Children's Hospital; Member American Orthopedic Association

WHAT I shall have to say in regard to scoliosis will be wholly the result of over five years' observation and study of a large number of all types of cases, varying from the slight functional deformities to those of the severe structural kyphotic type. During this period I have devoted the greater part of my hospital time the year round to the scoliosis department, and the methods in use now are but the result of an effort on my part to do the greatest good to the greatest number in the shortest time.

My paper will consist largely of an attempt to demonstrate to you by description and photographs the routine treatment of various types of structural cases and the results obtained at the Children's Hospital, Boston, first considering, however, the questions of gymnastic therapeutics and the mechanics of the spine as it has reference to the methods employed.

Before going further I wish to make clear that scoliosis is a definite bone deformity involving many bones, and is to be met as such. With this constantly in mind no one can fail to see the fallacy in the use of exercises alone in the treatment of such cases, even under the best hospital practices, or in the best conducted private clinics. Certain persons take the opposite view of scoliosis, and believe that by exercises alone for an hour or more a day a structural scoliosis may be cured, and call this exercising the rational treatment. Others similarly minded believe that something should be done to check the unscientific and often disastrous treatment of lateral curvature by spinal supports and prolonged recumbency. I agree with these statements in so far as they apply to recumbency alone and to the usual braces as applied for correction, but I cannot agree to their implied advocacy of gymnastic treatment alone in structural scoliosis of all types. Shanz[1] states that several years' experience has convinced him that the improvement obtained by exercises alone in scoliosis is only apparent in fully 99 per cent. of the cases. Exercising is important as a means of improving the general health, but has a slight effect on the scoliosis and may be harmful in certain cases, especially by increasing the flexibility and so allowing further slump.

Exercises, however, are of great importance in several ways *in connection with* the treatment

[1] Archiv für klin. Chir., xxxviii, No. 4.

Fig. 1. Boy, aged 17; marked kyphotic scoliosis. Treated by permanent jackets for 11 months.

Fig. 2. Same case as in Fig. 1, at end of 11 months. Still under treatment.

[1] Read before the New York Academy of Medicine, Orthopedic Lectures. New York. March 15, 1912.

Fig. 3. Case of marked kyphotic scoliosis, probably rachitic in origin, treated by plaster jackets alone.

of structural scoliosis. First, in slight cases exercises alone are often sufficient to establish a good holding position and in tending to restore symmetry, and thus insuring some improvement in those cases where jacket treatment is not advisable on account of too slight a deformity, or where it cannot for some reason be carried out.

Second, exercises are of great importance in connection with the production of flexibility in the spine precedent to or in conjunction with jacket treatment.

Third, exercises in connection with the wearing of removable jackets, which subject will be taken up later.

To expect free muscular exercises, however, to straighten to any extent bad spinal curves is unreasonable, for no matter how much these muscles may be developed by exercises, gravity in the erect position, combined with atrophy and bone distortion, is working against them the greater part of the waking hours of the patient, and it is obvious that no muscle can work to advantage and exert a corrective force during all or even a small part of this period.

I can only ask in answer to the advocates of the pure gymnastic treatment of structural scoliosis that they show as good results in an equal period of time as may be obtained by meeting the problem as one would any other bone problem needing correction, such as club feet, knock knees or bow legs.

Jackets, whether or not forcibly but accurately applied, mean above all precision in the application of the correcting force, and this force is

Fig. 4. Same case as in Fig. 3, in a jacket. Note window over concave side in front.

Fig. 5. Same case as in Fig. 3. Note window; also straightening of spine after 1½ years treatment.

Fig. 6. Same case as Fig. 3. Note effect of head traction.

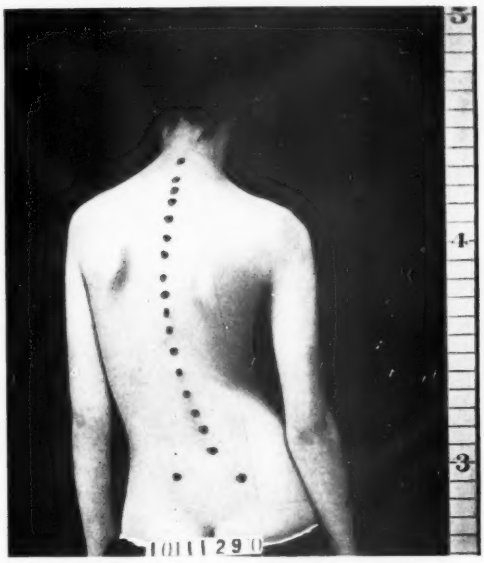


Fig. 7. Shows a case out of jacket.

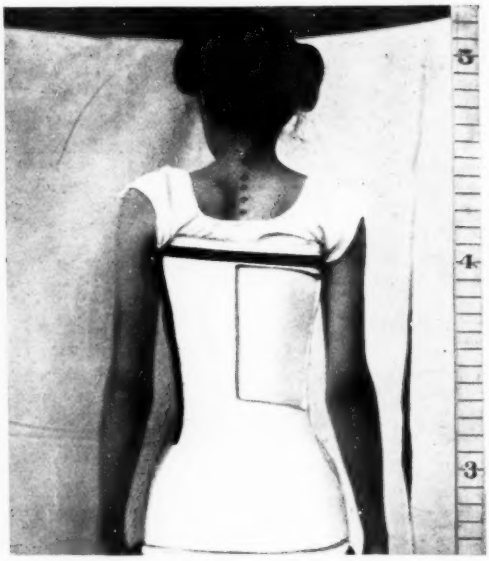


Fig. 8. Shows same case as Fig. 7, held by a removable jacket. Note window on concave side made to allow for expansion.

therefore better localized than can be done by exercises. This condition alone should determine the choice of the two methods. The criticism of the permanent jacket method is that great muscle atrophy is produced. This is perfectly true, and is purposely disregarded. Correction of bone deformity is the first, last and most important problem in these cases, and until this is accomplished the muscles play a minor part. Later, when all necessary or advisable bone correction is obtained, the muscles may be developed by suitable exercises. The time required for this development is not long, and they recover from a condition of marked atrophy to one of considerable power in a surprisingly short time.

The cause of these structural changes is outside the province of this paper, but I will state briefly that the deformity is generally due to—

1. Congenital variations or anomalies, such as spina bifida occulta, deficient, missing or fused ribs.
2. Infantile paralysis.
3. Empyema.
4. Asymmetrical growth.
5. Some bone change implying bone softening which may or may not be due to rickets, but where the bone resistance is evidently below normal.

This classification will be found to be adequate for all working knowledge, and with the routine use of the X-ray such conditions as may be present may be easily noted.

The ages of these patients have varied from less than a year to 18 years of age. The majority of cases, as in all hospital clinics, have been in girls.

For convenience of description I have divided the cases of structural scoliosis about to be discussed into two classes, namely:

Class I. Those with moderate deformity, which implies no great deviation of the spine or rotation, and consequently of course no great bony change either in the vertebrae or ribs.

Class II. Those with considerable displacement of the trunk, deviation of the spine and marked rotation, often amounting to a condition of kyphoscoliosis.

These two classes naturally call for different and definite lines of treatment, which will be outlined.

The total number of structural cases treated by jackets, with and without exercises, from January, 1908, to January, 1912, is as follows:

Class I, 50, treated by jackets and exercises.

Class II, 61, treated by jackets alone.

Of these cases the results were as follows:

Fig. 9. Case at entrance to clinic; right dorsal, left lumbar structural scoliosis.

Fig. 10. Same case as Fig. 9 after two years' treatment by means of exercises combined with wearing a removable jacket.

Class I. 2 cured, 13 marked improvement, 27 improved, 8 no change.

Class II. No cures, 25 marked improvement, 26 moderate improvement, 10 no marked change.

TREATMENT

In general the treatment to be advocated in this paper is based on the principle that bone is an adaptive structure and will alter its shape in the direction of least resistance, through pressure applied over a great length of time. The rapidity of these changes varies directly according to the age of the patient and the amount, direction and constancy of the force applied. As a general statement one must push harder in the opposite direction of the distorting forces for every hour of the twenty-four to accomplish anything. This can only be done by some rigid support having a firm pelvic grip.

In applying these corrective forces it is, of course, of advantage to use one's knowledge of the mechanical movement of the normal spine, which I will review briefly.

As the cervical region is of comparatively little importance I will omit it, but will take up the movements of the dorsal and lumbar regions.

The dorsal region is, of course, of the greatest importance, for here occur the most prominent and difficult curves and usually the predominant ones in any given case. As you all know, the dorsal region is the least mobile portion of the spine. In forward flexion there is very little movement, and the dorsal convexity is but very slightly increased. Hyperextension also is a very limited movement, and is confined largely to the lower portion of the dorsal region. Side bending is a more free movement than either of the two preceding ones, and is most free in the erect position or when lying on the face. It occurs less markedly in flexed positions and least in hyperextension.

Rotation is the most marked of the dorsal movements; it is more free than side bending, it is less in flexion than in the erect position. Hyperextension of dorsal region diminishes motion in direction of side bending and rotation.

In the lumbar region side bending is greatest in the erect position, and rotation is limited in all positions, but is greatest in the erect position. All movements except rotation are comparatively free in the lumbar region. Extreme forward flexion seems to lock this region against side bending and rotation.

Fig. 11. Same case as Fig. 9, showing effect of head traction on the spine as a whole. Skin has been remarked.

As may be noted from these statements the erect position gives the best opportunity for correcting rotation and side bending in the dorsal and lumbar regions. Therefore corrective forces applied with the patient in the erect position will naturally tend to produce the greatest amount of correction in the most economical manner.

Following this line of reasoning, I have put jackets on all of these cases in the erect position, using head traction so that the patient barely touches the toes to the floor. The pelvis is held by an assistant, for the double purpose of steadying the patient and exerting some counter pull. Also hyperextension of the spine must be prevented, and the patient's trunk must be kept in proper relations to the line of head pull.

It has been stated that side pressure on a slack spine is the most economical way to exert a corrective force. This is perfectly true in a normal spine, which was the type used for the experimental observations, but does not hold true in a scoliotic spine.

Head[1] traction in the erect position in a scoliotic spine tends to untwist the whole spine, and therefore is distributed to the whole spine. In diminishing the rotation is naturally tends to correct the lateral deviation.

If in correction with head traction a side push is used one has two forces acting to straighten a curve, and the resultant force of these two forces acts as a unit in straightening and lengthening the spinal column. This is a perfectly obvious and reasonable mechanical problem.

Besides the mechanical efficiency of this erect position associated with head traction, there is one other factor to be taken into consideration, namely, its simplicity of use in a large clinic, where time is of value and where as many as ten to thirteen jackets have to be applied in a few hours. It allows the use of as much corrective force as should be used on ambulatory cases living at a distance from the hospital, and yet if the jacket is accurately and snugly applied holds the case in an admirable and improved position, and exerts considerable corrective force. These jackets have the usual windows cut out on the concave sides back and front, that is, in the diagonal diameter of the thorax opposite to the areas of rotation, after the method devised by Wullstein and used later by Hoke and Adams, through which the areas of rotation are padded each week by pulling in thicknesses of felt. When the padding is increased to such a thickness that no more efficiency is to be expected, the jacket is removed and a new one applied in the same way. Four to eight weeks is usually as long as a jacket is efficient.

During the past five years I have carried out two types of treatment on a similar class of cases for the purpose of observing which type was the more efficient. These two types were (1) the treatment which consisted of having the patient wear a removable jacket and do exercises at least four times a week, and (2) that which consisted of putting the patient into a permanent jacket, with weekly padding.

This study has not been without interest, for it has shown that with both types under equal care and supervision type two has always improved more in a shorter space of time than type one, the cases have been far easier to handle, and the results far more satisfactory.

The routine treatment in cases of slight structural scoliosis is best carried out by jackets either with or without exercises. These jackets are made from remodeled plaster torsos, which have been made from a jacket taken of a patient in the erect position with head extension, which gives one the best corrected position as a basis for all further corrective work. A short period — one

[1] Wullstein, 1897.

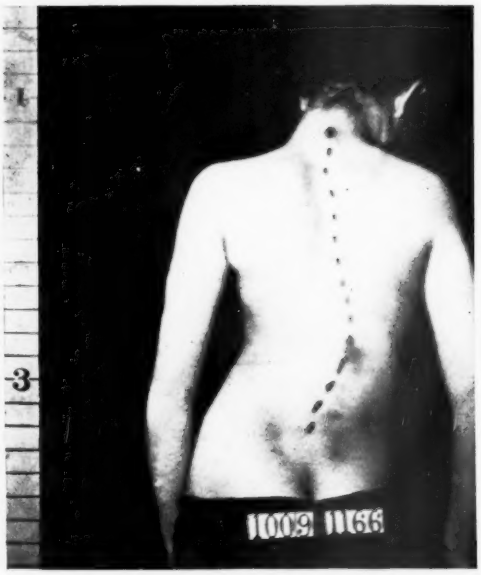


Fig. 12. Case at entrance to clinic; right dorso-lumbar structural scoliosis. Cause, rickets; treatment by permanent jackets.

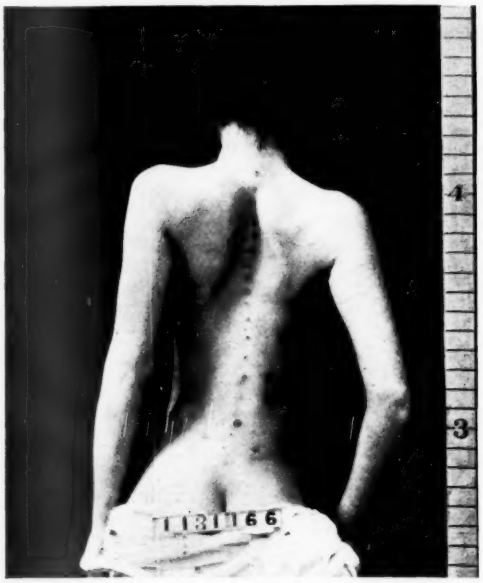


Fig. 13. Same case as Fig. 12, showing end result. Curve cured, but marked muscle atrophy present. Patient at present wearing brace and doing exercises to develop muscles.

to two weeks — of hard flexibility work may be given before taking this preliminary cast, for the purpose of loosening up the spine. The original jackets are applied without any padding so as to get a snug skin fit. Great care is taken to get an accurate pelvic fit. These torsos are then further corrected by shaving off over the side of the rotation and adding if necessary over the concavities. Their power of extension may be made still more efficient by cutting them in two at the waist and setting the halves apart, according to the degree of the patient's flexibility. A check is kept of the efficiency of these jackets by means of frequent measurements of the patient's height. Four measurements are recorded as follows:

1. Best standing position.
2. Position with hands on hips pushing up (limit of flexibility).
3. Position held by jacket.
4. Position with hands on hips pushing up in jacket.

If a case is held at her limit of flexibility in the jacket, as shown by comparing her height record when pushing up with hands on hips out of the jacket with her height as held by the jacket, that is all one can expect to do at that time by that type of jacket. As flexibility increases through exercises and use of the jacket, then the extra flexibility must be taken by up pads and later by a new jacket, following a further remodeling of the plaster torso. In general it may be stated that from three to six weeks is about as long as a jacket is really efficient, and it becomes necessary to alter the torso or to take a new cast and start fresh again. Many remodelings of the torso lead to marked changes of important relations, and it is better and easier to take a new cast than to attempt further changes, which will result in a poorly fitting jacket.

Jackets must be worn for long periods, that is several years, to obtain permanent results. It is better to have these jackets made of plaster, for they are cheaper, do not take long to make and are not worn long. A leather jacket takes several weeks to make, is expensive, heavy, and stretches, and in a growing child under active treatment will probably not fit efficiently for any length of time. The exercises in these moderate cases are for two purposes, namely, flexibility first, and then muscular development, and so holding power. They are always of special selection and asymmetrical in character, such as those which increase the backward flexibility of the spine against the direction of the deformity,

and increase the rotation of the thorax in the direction of the normal plane. Exercises should not be pushed beyond the limits of fatigue, and the length of treatment, the period of exercises, and the extent to which they may be pushed, depend wholly on the condition and vigor of the child.

These removable jackets are made more efficient by cutting out the greater portion of the concave side, so allowing the patient to expand through this opening. Also in the mid-dorsal and upper dorsal cases, a steel shoulder pad, covered with felt and leather, is fastened on the jacket in front of the high shoulder to act as a point of counter pressure to that shoulder, and to prevent its falling forward.

All of these jackets, removable as well as permanent, are made of the usual dental plaster with the addition of five per cent Portland cement, which greatly increases their elasticity and durability.

A permanent jacket offers the best method of treatment for hospital cases, and is applied in the usual manner. It is reinforced by strips of plaster bandage vertically placed in front and over the rotation on the back, and by a plaster rope around the top. Large windows are cut out over the concavities in the usual manner. Great care is taken to get an accurate pelvic fit, and no padding is put under the jacket but four thicknesses of sheet wadding over the crests of the ilium. The more padding that is put under a jacket the more unsatisfactory it is with respect to fit and stability. You are all familiar with the jackets which have a lot of felt underneath them and no pelvic fit, which slip up and down on the patient. These jackets can of course offer no adequate base of support for the corrective force. Jackets which have a lot of padding beneath them also are much more likely to cause sloughs than those which have little or none, for the padding slips about and rolls up, creating ridges and edges which press unevenly on the skin. With my method we have had no sloughs except a few from too great pressure over the areas of rotation, and rarely in the axilla from too great counter pressure. These have been small in extent and easily dealt with.

In the great majority of cases it is not necessary to carry the jacket above the highest point one can get it in the axilla on the concave side of the curve. Mechanically it would appear that adequate pressure could not be exerted unless the jacket were carried above the axilla and given a point of counter pressure on the side of the neck. In only a very few cases has this been necessary. The neck, on account of the important anatomical structures situated there, such as the arteries and brachial plexus, does not tolerate long continued pressure, and except in a few very high cases the indications can be met by the ordinary jacket, or one supplemented by a cuirass, which relieves the trunk of the weight of the head and neck.

In padding these jackets care must be taken to see that the padding is accurately placed directly over the crest of the rotation. If placed too far at the side, the displacement will be corrected at the expense of the rib distortion, which will be increased backward sharply. The padding is all done from the back, and I can see nothing to be gained by padding from the front. Pressure, as expressed by increased padding, is exerted through the diagonal plane of the rotation, and is therefore presumably as great in front as in the back. On the other hand, the trauma caused to the breasts and nipples in girls by padding in front is great, and I have seen sloughs of the nipple from this method. It likewise causes considerable distortion at the costo sternal articulation, without causing any more corrective force on the rotary element of the scoliosis, on account of its questionable transmission through the length of the ribs. Pressure does the greatest good where the rotation is greatest, and wherever that is, that is the place to apply it.

# SILVER WIRE CABLE AN IDEAL BURIED METALLIC SUTURE

By HOWARD LILIENTHAL, M. D., New York City
Attending Surgeon to Mt. Sinai and Bellevue Hospitals

FOR more than five years I have been employing a silver wire cable, when I felt the need of a nonabsorbable permanent buried suture material. The idea occurred to me when handling a piece of ordinary picture-wire and noting its great strength and pliability, and my first idea was to devise a very strong, and yet very pliable, metallic suture. When the finished product was put into my hands I was at first disappointed in its strength, but later I discovered that it possessed other qualities so remarkable as to more than make up for my first disappointment. The cable is made of from four to six strands of number 34 or number 36 fine silver wire very loosely twisted together and then throughly stretched, in order to get rid of the slack due to twisting. The cable, then, is not unlike miniature picture-wire. It is extremely pliable, so that it can be threaded into the eye of a needle instead of having to be drawn through the tissues with a piece of silk. When the suture is in place it can be tied with two or three knots, the same as an ordinary stitch, and the ends can be cut off close. It does not slip. Strong traction will cause it to break at the knotted place, but the suggestion was made to me by Dr. Elsberg that threading a piece of very fine catgut into the needle along with the cable would probably obviate this difficulty. On making the test I found that the suture would then stand very strong traction even though it were knotted. The individual wires are so extremely thin that their ends do not irritate the tissues; indeed, it is impossible to prick the finger or even the tongue with this fine silver wire. For this reason, and probably also on account of the active antiseptic power of the silver itself, the cable does not act like a more solid metallic substance, such, for example, as silver wire of equal thickness, and it will remain in the tissues, healing in firmly even though suppuration is present. It is this latter quality which has most strongly recommended the employment of this suture material in properly selected cases.

In addition to its use in bone surgery it is of great value in the suture of the aponeurotic structures in closing the abdominal wall in the presence of infection, for example, in an infected strangulated hernia. I have repeatedly employed it, even when there was gangrene of the intestine soiling the entire field, so that any other material with which I am familiar would itself have become infected and would have had to be removed. The wire cable, however, remains in place and is gradually covered by the granulations much the same as if it were a part of the patient's tissues. It is also excellent for the manufacture of metallic filigree for closure of defects in abdominal wall, although here it is, of course, necessary to have sufficient cutaneous covering to avoid great tension immediately over filigree.

To summarize: The silver wire cable possesses great pliability and can be threaded and knotted the same as a piece of silk or catgut. To fasten a suture it should be tied in a square knot, not twisted as ordinary wire. The ends may be cut off short.

If there is to be considerable tension in tying the knot a piece of fine catgut of equal length should form a part of the suture.

In the event of suppuration the cable does not act as a foreign body and will not come out unless there is sloughing of the structures through which it passes.

Now, after more than five years' experience with this suture, I feel justified in advocating its employment in suitable cases. It is not supposed to take the place of any other suture material, but occupies a unique position in the armament of the surgeon.

# TRANSACTIONS OF SOCIETIES

## CHICAGO SURGICAL SOCIETY

REGULAR MEETING HELD DECEMBER 1, 1911, WITH THE PRESIDENT, DR. FREDERIC A. BESLEY, IN THE CHAIR

SYMPOSIUM: ABNORMAL POSITIONS OF THE INTESTINES — LANE'S KINK, JACKSON'S MEMBRANE AND ALLIED CONDITIONS

DR. DANIEL N. EISENDRATH read a paper entitled, "The Clinical Importance of the Movable and Non-rotated Cæcum."

DR. PAUL F. MORF followed with a paper on "Sliding Hernia." (See p. 333).

Other participants in the symposium were DRS. ALFRED C. CROFTAN, WILLIAM R. CUBBINS, FRANKLIN H. MARTIN, A. J. OCHSNER, M. L. HARRIS, JACOB FRANK, F. GREGORY CONNELL.

### DISCUSSION

DR. ALFRED C. CROFTAN was asked to open the discussion on these papers. He said:

From the standpoint of a physician who does not operate, it is a difficult matter to open a discussion of this kind. I hoped that I would be allowed to close it.

Anything in regard to surgical methods or technique is foreign to my field of work, and I have nothing to say about them. I can venture something, however, in regard to the indications for this operation, something in regard to the symptomatology and diagnosis, something in regard to results obtained from surgical and from non-surgical methods. I want to confess that much of what I have to offer is not based on a large personal experience but rather derived from what I have seen, heard, and read.

In the first place, as far as the colon mobile is concerned, I have not been able to convince myself from the anatomic literature and from my memories of the dissecting room that a movable colon is really a distinctly pathologic condition. Personally, I would be more inclined to look upon a fixed colon as abnormal. One of the German writers, in fact, who has written voluminously on the subject, claims that the best method of treating colon mobile is to make it still more mobile, instead of fixing it. I should consider it rather precarious to anchor a movable colon too tightly, especially in women, and in women particularly movable colon is immeasurably more frequent than in men, for in pregnancy there must be yielding of the colon upward and forward. It would be interesting to watch the effect of fixation of the colon in a woman who subsequently became pregnant.

So far as the symptomatology and the diagnosis of colon mobile are concerned, I would not attempt to make a diagnosis from the symptomatology that Dr. Eisendrath has given us. As far as I can determine, the diagnosis is usually made at the operating table, as an incident to an operation for appendicitis or perityphlitis; especially in cases presenting symptoms that apparently justify the operation for appendicitis, but in which upon operation not enough pathology is found in the appendix to really account for the symptoms. This would constitute a plea for a large incision in every case, as otherwise Jackson's membrane, Lane's kink, colon mobile, etc., that really caused the symptoms, might be overlooked.

In the unopened abdomen, I am impressed more with the vagueness of the symptoms described than with their definiteness. To me the picture means nothing more than that of a neurotic person, of either sex, chronically constipated, with possibly a little resistance in the cæcal region or above it, sometimes confused with floating kidney. One also hears described a "gurgle," which is said to be diagnostic, and there is no fever, no acceleration of the pulse, no stiffness of the rectus muscles on the affected side, none of the ordinary inflammatory reactions. There is some pain spontaneously, and on pressure, and general discomfort on that side, usually cutaneous hyperesthesia and perhaps a group of more or less vague and indefinite reflex symptoms.

These signs do not suffice to make a positive diagnosis, especially if the patient is afflicted at the same time with a general enteroptosis or visceroptosis. To operate here means to cut for general results on suspicion. It must, of

course, be very comforting and safe to say: "I do not know whether you have appendicitis, but, if not, you probably have a Jackson's membrane, or a Lane's kink, or a colon mobile"; and one will usually be correct, for nearly seventy per cent of all people have a movable colon. Just what to do, however, when no appendicitis is found and a movable colon is discovered instead, is another question. So far as my analysis of surgical results is concerned, I have been rather disappointed in all the papers I have looked through. There is a lack of critique. Most of the authors hold a brief for certain preconceived notions and ideas, they are intent on making the punishment fit the crime. A recent article by Dr. Gregory Connell is the most satisfying one to me, for he presents a critical review of the subject. His summary of conclusions, however, is merely his catalogue of doubts; but that is at least honest. Most of the German papers I have read give only positive results and seem to ignore negative findings. In the successful cases reported, morevoer, the time that has elapsed since the operation is too short to warrant definite conclusions in regard to the permanency of the results obtained.

The purely psychic element, moreover, that Dr. Eisendrath mentioned is never sufficiently eliminated from the equation to suit me. So many of the cases occurred among chronically constipated neurotic individuals with pain in the right side and appendix phobia, and here there was temporary relief of the constipation and the pain. I have had experience with two cases of this class that were operated by Dr. L. L. McArthur; both were typical neurasthenics, with constipation and definite anatomic abnormalities in the right lower abdomen. The surgical part was a perfect success; the work beautifully done, the anatomic defect corrected secundem artem, and the temporary result brilliant. Both these patients soon, however, became as sick as ever; one had a colica mucosa, and she still has it, and the other is still constipated, just as neurotic and just as full of aches and pains as before.

What I should like to have brought out in this discussion, aside from the technical side, would be a safe guide to diagnosis through the intact abdomen and a summary of the results obtained, not of temporary success in one or two cases, but of permanent success in a large group of cases.

Dr. William R. Cubbins: I do not think that stating that in sixty or seventy per cent of these cases the condition spoken of is congenital and in thirty per cent of them acquired, is doing justice to the acquired proposition. I really believe, with Mr. Lane, that the colon is largely movable and is dilated; and that the dilated portion is the result of the fact that it contains heavy fluids to be absorbed. That is the heavy portion of the bowel content, and it is forced into this bowel which is upright, the churning up and down and carrying weight being more of an active factor in the production of movable cæcum than is commonly supposed.

With reference to the production of the Lane kink, I have heard perhaps a dozen different discussions on it, and I should say that a great many men have a wrong conception of it. Mr. Lane contends that as the cæcum becomes overloaded with fluid or feces it gives rise to the formation of a mass; that there is a thickening of the peritoneum on the outside of the cæcum which is shown as a line and loses itself upon the inner side of the abdomen and on the side of the iliac fossa. The next thing is along the posterior portion of the ileum, where the mesentery is very short; as the cæcum is pulled down, it tends to draw the ileum in the direction I show you on the blackboard (illustrating), so that right under here there is the development of a broad band, which, as it contracts, causes the ileum to assume a shape not unlike this (indicating), due to the fact that this band holds the weight of the loaded cæcum.

Mr. Lane gives this outer band as one of the causes of appendicitis. If this band is around the neck of the appendix, and it is pulled, as the cæcum slips down, the neck of the appendix is blocked, so that there is a possibility of irritation and fermentation distal to that point. If the appendix comes up and backward with this band, we also have a kinking and blocking at the entrance of the appendix into the cæcum. If the appendix has been adherent under the ileum a previous inflammation having existed, the appendix being pulled in this direction by the loaded cæcum, and the outer band pulling at its neck, we have there another method by which the outlet may be blocked.

Since I have been on the lookout for the Lane kink, I have during the last five years seen a number of cases which were very distinct. Last week I had the pleasure of seeing the first case in which there was also Jackson's membrane, and this membrane was very distinct, and covered the cæcum distinctly. It was a light, delicate membrane, slightly above the cæcum, and it appeared to me to have blood vessels in it. This membrane fused with the Lane bands; it started

out from the ends of them and fused distinctly with them.

As to the symptomatology of this condition, as it is described by the German authors, it is the same condition as that which has been described by Moynihan as appendiceal indigestion. It is the same condition that has been known as neurasthenia the world over, and it brings us back to the proposition, is it possible that we are dealing with a hypochondriac or a neurasthenic, or are we not dealing with a patient who is markedly intoxicated from absorption of the bowel contents? If that is so, the removal of the colon or sigmoidostomy also is undoubtedly the solution of the problem of intestinal intoxication.

I removed the colon in one case to the splenic flexure, and since that operation the woman has improved remarkably. I had enough adhesions to satisfy the desire of any one. In spite of the fact of dense adhesions, she has improved markedly. I removed her colon on the advice of Mr. Lane himself.

In regard to the movability of the cæcum and fixing the cæcum, it seems to me, that where we have a condition of the cæcum in which there is the accumulation of feces and fluid in the bowel, these having gone on to such an extent that we have a dilated wall and a markedly inefficient musculature, it is far better to follow the Lane procedure and put the ileum into the sigmoid. It is not a difficult procedure, and I do not believe it would be followed by very many serious symptoms. While I have followed this in two or three rather unusual cases, I am not ready to talk about it.

In reference to the nomenclature of hernia, it seems to me that instead of calling it sliding hernia, it should be named hernia of a sliding viscus.

I would like to ask Dr. Morf what relation the distal end of the sigmoid bears to the mesosigmoid when we have a hernia of that type. Is the sigmoid the lower part, or has the mesosigmoid the hernia with it?

There are men who claim that these cases of neurasthenia and hypochondria can be relieved by washing out the colon, and by the use of intestinal antiseptics. There is one man who has been talking considerably about the use of colon bacilli vaccines. I have myself experimented with a vaccine of the colon bacillus and with one result that was nearly fatal, and I have not much to say about that at the present time.

DR. FRANKLIN H. MARTIN: There is one point to which I wish to call attention before proceeding with some other remarks in regard to the rotation of the colon.

The ascending colon, after its rotation and the assumption of its normal position, is separated in its mesentery from the mesentery of the ileum, and this distinguishes it in its normal condition from the so-called mesenteric commune. In other words, if the mesentery of the ascending colon does not separate from the mesentery of the ileum, you will have a continuous common mesentery for the two, as is found in some of the lower animals, especially the bird. As the mesentery of the colon separates from the mesentery of the ileum, it forms its own attachment, if the colon rotates properly. It rotates to the side of the abdomen and the whole posterior layer of its mesentery as it comes in contact with the posterior abdominal wall blends with the peritoneum that existed there before the rotation occurred. An obliteration of the posterior layer of the mesentery follows with the blending of the peritoneal surfaces and the colon is fixed by that process of obliteration. At the same time, the ileum forms its own separate mesentery. The mesentery of the ileum at its terminal end is only from one to two inches in length, while higher up the mesentery gradually lengthens to nine inches at its greatest length. This arrangement makes the last six inches of the ileum the fixed portion of the intestinal canal in normal individuals.

The bearing that this has upon the Lane's kink, in my opinion, is this: a great many of these cases are of the congenital type, but because an individual is congenitally defective in one portion of the intestinal tract, it does not necessarily follow that he will be congenitally defective everywhere. For instance, Treves a great many years ago showed in one hundred cases where the right colon was unblended in twenty-five cases and the left colon in thirty-three and a half cases, showing that you may have a congenital defect in one portion of the individual and not in another. The bearing this has upon the Lane's kink is this: in some cases the last four inches of the ileum is fixed with its one and a half or two inches of mesentery. If the ascending colon is unblended, as it is in twenty-five cases in a hundred, the cæcum with its weight and fluids naturally gravitates into the pelvis. If the abdominal wall supports are congenitally weak, allowing the abdominal contents to gravitate below their normal zone, or other peritoneal blendings other than those of the colon are congenitally defective, allowing the viscera to prolapse, a general pull will occur at the fixed end of the ileum.

All these gravitations into the pelvis will of necessity pull upon the stationary ileum and kink, distort and traumatise it; and if the appendix becomes diseased at the same time, it will frequently convey infection and inflammatory adhesions to the distorted and kinked ileum. In some of these cases the adhesions are not caused by septic irritation but by mechanical irritations. I believe that the peri-colic or Jackson's membrane, which very often accompanies the Lane's kink, is produced by this same mechanical irritation.

An operator may at any time demonstrate the method of producing a Lane's kink by drawing down upon the cæcum when the abdomen is opened. If it is a normal cæcum pulling upon its attachments forcibly, you can immediately notice the pull on the short mesentery of the ileum. And what does it do? As the mesentery of the ileum pulls, this portion of the ileum is kinked and the pull of the mesentery rolls the ileum directly beneath its mesentery.

I have seen, probably, thirty-five cases of definite Lane's kink in which I am positive there were pathological symptoms as the result of this kink. I have operated upon at least twenty of these myself. I have demonstrated this kink repeatedly and satisfactorily to my assistants and physicians who were present. I have seen these kinks in the clinics of the Mayos, Dr. Ochsner, and others, where there was absolutely no question about their pathological importance, and where it would be ridiculous to wash out the colon, because one had obstruction of the small intestine at this point, in order to relieve a toxæmia which may have occurred as the result of a definite obstruction in the ileum.

What are we to do with these cases? If a definite percentage of all individuals have this loose colon or other viscera, producing or aggravating an appendicitis and causing obstruction of the ileum, leaving but one eighth or one fourth of its caliber still acting, I say, what are we going to do? It is not an irrational thing to make an attachment of the colon, particularly in those cases where the colon is unattached. It is not an irrational thing to make it exactly as was described by the essayist of the evening, namely, by attaching the parietal peritoneum to the peritoneum of the bowel and the right layer of its mesentery, because in a short time the posterior portion of that mesentery, will become obliterated and it will form the same blending exactly that you get when nature performs the same thing early in embryo in fixation of the colon. Therefore, if the colon is down and you can demonstrate that it alone does produce a kink, there is no reason why that colon should not be lifted to its normal position and the posterior layer of its mesentery blended with the parietal peritoneum. But in many of these cases we have other conditions existing. We have, instead of the musculature of the strong abdomen of the normally developed human, the abdomen of the lower animal, the fascial parieties instead of muscular parieties. Instead of having the cavity of the trunk of the abdomen a cone, the apex of which is at the pubes where we should have it, and with the base of the cone at the upper end of the abdominal cavity, we have the cone reversed, and every reason in the world exists why all of the organs of that individual should gravitate into the pelvis. First, because there is not the normal abdominal muscular support, or at least the muscles are very inadequate. Instead, we have the fascia-lata type of the lower animal, a congenital condition showing a reversion of type.

In regard to the definiteness of this condition: Up to within the last two years we have had to guess at these things, and we were accused, those of us who have been working more than others along this line, of mental defects because of our persistency in pursuing the subject. Now, fortunately, we have a method of absolutely demonstrating the exact location and whole length of the intestinal canal. We can take forty patients well or sick, feed them bismuth mush, and make skiagraphs every four hours until the bismuth mush has passed from the stomach through the pylorus into the small intestine, into the large intestine, the transverse colon, the descending colon and into the rectum. We can trace every point, so that the question of diagnosis is no longer in doubt. It is unnecessary for us to guess if there is obstruction at the ileo-cæcal valve. We can give the bismuth mush and demonstrate it. One can see from the pictures that there is a probable obstruction because of the slowness of the bismuth meal in passing through the pylorus, ileo-cæcal valve or sigmoid.

One other point is with reference to the care of these patients after operation. If a patient has an obstructed portion of the alimentary canal, I believe as surgeons we should relieve that obstruction, even if we do relieve a patient of something that has been called neurasthenia; and in order to do that it is absolutely necessary to make the incision large enough through which to make a thorough exploration. You cannot correct the adhesions about a Lane's kink very well or even discover it very well, through a gridiron incision an inch in length. A right

rectus incision large enough to admit the hand is fully as good an incision, and if it is properly closed there is no more reason why there should be a hernia. Therefore, in all these chronic cases, where the diagnosis is more or less obscure (where you have not pus or other contraindications) make a right rectus incision large enough to find out what is going on within the abdomen, and after you have found out, room enough in which to make the corrections.

While in Philadelphia last week, in watching some of the work by Dr. Clark (and he is doing some wonderful work along this line, studying his cases carefully with the X-ray, operating on some of them, comparing the exploratory findings with the X-ray, showing definitely what he is about), I noticed that he made a rather liberal incision. After he had corrected his pathology, with the patient in Trendelenburg position, he filled the colon with normal salt solution through the rectum, and while making the toilet of the peritoneum, he traced the water as it passed the descending, the transverse and ascending colon until it reached the ileum, thereby demonstrating definitely the exact contour and condition of the large bowel from end to end.

This maneuver, so simple and so effective in leaving the large bowel filled with hot water, makes it absolutely unnecessary to overlook any defect in the large bowel.

The cases that are operated upon, and the kinks and adhesions corrected, should be treated afterward in a rational, hygienic way. They should be put in the Trendelenburg position on return to bed after operation, so that if these troubles are caused by prolapse of the organs these organs will retain their normal position during convalescence. They should be properly bandaged on leaving the bed. The abdominal walls should be properly exercised. There are ways of not only developing the muscles, but one can teach these individuals to massage their pelvic and abdominal contents by contracting the psoas muscles while lying on an improvised Trendelenburg table. All of these things should be carried out with the idea of keeping the organs in their position and in the acquired cases of enteroptosis, you not only can afford relief, but bring about a cure in some cases. By carrying out the same treatment in the congenital cases, after you have relieved the kinks and obstructive adhesions, you can keep them well indefinitely.

DR. A. J. OCHSNER: I believe, with regard to the diagnosis of sliding hernia, it is wise to follow this rule. In all cases in which a hernia cannot be retained, or in which it cannot be reduced satisfactorily, we should suspect a sliding hernia, as we have found sliding hernia in a large number of these cases. If one follows the precautions that Dr. Morf has given, one is not likely to get into trouble with sliding hernia. On the other hand, if one operates rashly without this consideration there is much danger of injuring the intestine.

We had a sliding hernia recently containing the sigmoid and the bladder, which is one of the conditions that must be borne in mind.

Regarding movable cæcum, I would say that it is a condition which is so common that it is difficult to speak of definite effects so far as the patient's health is concerned, excepting in cases in which it causes obstruction and this in turn the absorption of products of decomposition.

The idea that Wilms brought out corresponds with an observation that I made many years ago in making a study of hernia in children. I found that hernia in children could be almost always cured spontaneously by removing the intraabdominal pressure due to gaseous distension, by giving attention to the diet and to evacuation of the bowels, and elevating the foot of the bed so as to aid gravitation in the decrease of pressure. Wilms found that these children with enteroptoses suffered from gaseous distension. I believe that in many cases all of these conditions, movable cæcum, the dropped kidney, the dropped transverse colon, the tremendously pendulous and displaced descending colon gastroptosis and enteroptosis can be attributed to faulty feeding of children; that is, as a result of the faulty feeding there is gaseous distension of the stomach and the intestines, the mesentery and all the supporting structures are stretched out of shape, and as a result of that stretching we have a dropping down of these various organs, and as a result of the displacement we have a degree of obstruction established, and with the obstruction that has been thus established we have still further stretching. Thus we have a vicious circle established, so that we have one thing after another, and each one makes the next one worse, and as a result we may have any one of these displacements with its resultant functional defects.

As regards the cure of these patients suffering from movable cæcum, I believe that there is very much of suggestive treatment in it. With faith we can move mountains, and with faith we can move bowels. If a physician has unlimited faith in what he is going to do, and the patient has unlimited faith in what he can do with his bowels after the operation, I have no doubt but what a

great deal of benefit may be derived from this method of treatment. I do not believe that we can speak of anything except temporary benefit in these cases except in so far as we can relieve the obstruction.

In cases of Lane's kink, where you have a definite obstruction, there can be no doubt about the fact that you can correct or relieve the condition by Lane's operation or any other operation that actually relieves the obstruction. In those cases, of course, you establish conditions which more nearly approach the normal; but they are not normal conditions. Nevertheless, I have seen personally excellent results from this operation in cases of at least three or four or more years standing.

There is one point I wish to mention in regard to the effect of peristalsis. If one opens the abdomen and causes peristalsis, one finds that the intestine pulls itself against the mesentery. Where we have a pendulous condition, such as we have in these movable cæci, this action is practically not possible and you have simply a kind of rotatory action for the purpose of forcing the intestinal contents forward. As the air or anything else touches the intestines you can see this particular action, which would be difficult for the loose intestine to perform. Fastening up one of these movable cæci has always looked to me as not very promising because by so doing we do not accomplish anything like a normal condition. If one simply fastens a thing that is loose and does not fasten it so that it is something like it should be if it were normal, it has always seemed to me as though one has not done very much for the patient, and I should want to see some of these patients a long time after that has been done before becoming satisfied that the operation was a success. We have all seen patients who after the most trivial operation have felt very much better, when the real thing that was the matter with them has not been touched. I have seen many such cases that were very much better from gall stone trouble by simply having the appendix removed. For five or six weeks or two or three months they were directly under the doctor's care and had to live in a fairly reasonable manner, and some of them may form the habit of living in a reasonable manner permanently, and, notwithstanding the disturbance of the gall-bladder and the presence of stones, they were very much better for a while, but sooner or later the gall-stone trouble recurred. Their improvement was incidental, and I should imagine that the improvement which we hear reported in these cases of fastening up movable cæci will probably have to be classified presently as incidental improvements.

Dr. M. L. Harris: I do not know what to say on this subject, because my mind is, perhaps, in as great a state of chaos as is this subject. For several years I have been of the opinion that troubles in the right half of the abdomen formed one of the most important subjects that we knew almost nothing about. The subject has been handled and dealt with by men who have had, and hold, a very narrow view. They have seen one thing and have been unable ever thereafter to see anything else, and all of the symptoms and troubles which occur to patients have been attributed to this one thing. For instance, one man sees a little kink, and his mind becomes kinked ever after. Everything to him is due to a kink. Ulcer of the stomach, dilatation of the stomach, duodenal ulcer, appendicitis, all manner of cases of neurasthenia and hypochondria are due to one little kink. Another man sees and finds a movable organ and he never can get any further, and everything is due to that, just as we heard here three or four weeks ago what I thought was one of the most absurd papers I ever listened to in my life. You will remember that all manner of diseases of the stomach and of the duodenum, appendicitis and constipation, colitis, and every form of mental disturbance, were due to the one thing, movable kidney; and if the movable kidney was fixed, all the trouble disappeared. If you straightened out a kink of the gut all the symptoms disappeared. Another man says it is not a movable kidney, but it is a movable colon that makes the movable kidney, and if you fix the movable kidney, it does not do any good, but after the colon was fixed, lo and behold, all of the symptoms disappeared. If we say that these patients get mental troubles by having their mind dwell on some particular trouble, as the loose kidney, how much more should we think of the physician who gets mental trouble by having his mind dwell on one little condition?

What we lack is a broad view of the subject, something that will correlate all the different conditions we find in the abdomen giving rise to these symptoms, and show what the common factors are in these cases. Let us see if we can find out what the cause is. We open the abdomen and we find the colon is too movable. We fix it in one patient with temporary relief of the symptoms. The next patient has the same symptoms, we open the abdomen, and we find the colon is too much fixed. We unfix it, and cure some of the symptoms. Certainly the same

symptoms are not due to the fact that the colon is too firmly fixed in one case, and in the other too freely movable. There is something else back of all this.

That there is such a condition as the Jackson's membrane is very certain. That these patients have very characteristic symptoms I think is true. I believe I am able to recognize patients in which I will find this membrane by the symptoms before I open the abdomen. I have done it so many times that I am quite certain these patients present characteristic symptoms sufficient to enable one to recognize it and to predict that there will be found this condition when the abdomen is opened. But what to do with it, after we get in there, is entirely a different matter. I have removed this membrane a great many times, and while most of the patients got much better, in some, the trouble recurred. They were not permanently cured. The direct trouble is not this membrane. It is something else. What makes the membrane? What causes the adhesions? These are things we ought to know before we can give these patients any rational treatment. The same thing obtains with regard to movable cæcum. I do not think it is always the movable cæcum that makes these patients ill because we find lots of patients with movable cæci when we open the abdomen for other troubles, who presented to symptoms due to movable cæcum. I opened the abdomen in a case two weeks ago and saw one of the most movable cæci and colons I have ever seen, with a large, complete mesentery. The ascending colon could be taken right out of the abdomen, but I do not think that was causing the symptoms in that patient. If a gynecologist had looked into the pelvis of that patient he would have explained all of the symptoms the patient complained of by what he could see in the pelvis. There was, in addition to the movable cæcum, one of the worst cases of varicocele of the pampiniform plexus I ever saw. The veins were as large as you see them in the last months of pregnancy, the varicocele being enormous, filling the whole right side of the pelvis. That was the trouble. The gynecologist would have said that was a beautiful case of varicocele of the infundibulo-pelvic ligament. He would have operated on that probably without looking at the cæcum before our attention had been called to the cæcum. Another one would have seen the cæcum and have overlooked the other trouble. I took out the appendix in this case and operated on both the other conditions, but I do not know whether that woman is going to be better or not. We shall see later.

The same way with Lane's kink. I have seen many patients who had what has been described as Lane's kink, but I do not believe this kink produces duodenal ulcer, as Lane says. I do not think it is the case at all. I am free to acknowledge that I am very much in the dark as to the cause of these troubles that we find centering around the colon. I am operating on them, as all of us are, almost every day, but I am still groping in the dark to know what to do with them. When I get a case of marked so-called Jackson's membrane, I do not know what to do with it to cure the patient. I am doing something to them, but unless we can go back further and find the cause of the membrane, we are not going to relieve these patients permanently by doing anything to that membrane.

We find a similar condition on the left side of the abdomen about which nothing has been said, and that is, adhesions of the sigmoid. I am perfectly satisfied that these adhesions of the sigmoid give rise to a number of symptoms, but what to do for this condition I do not know. I have liberated these adhesions and have had the patients remain well for several months or a year or two, and then some of them would have a return of the symptoms. If we were to open these patients again we would probably find a recurrence of the adhesions, so there is something back of the adhesions. One thing which I feel must be at the bottom of these troubles, and I say it while realizing that I have no proof of it, and that is some trouble with digestion. There must be, to my mind, some abnormal products probably of bacterial origin, produced in the intestines which are absorbed, or which by their chemical effects cause a pericolitis, adhesions, atrophy of the muscle, dilatation, etc., and until we get at the bottom of that we will not be able to permanently relieve these patients.

I cannot take so much stock in Dr. Ochsner's belief that they are due to improper feeding in childhood. If that were the case we ought to find them in the male as much as in the female. We do not do it. The great predominance of these cases is in women. Boys are ill-fed just as much as the girls, but the condition does not arise so frequently in men as in women.

If I knew more about this subject, I might say more, but I do not.

DR. MAX REICHMANN: Just a remark with reference to the radiographic side of this question which has been alluded to by Drs. Eisendrath and Martin. There is nothing more deceptive than a radiogram of viscera, and if roentgenology should give us any results, then we have to use

the fluoroscope and see the intestines as they are physiologically. A picture which we may take at one minute may in the next minute or two change altogether.

I had the pleasure this summer of visiting the clinics of Drs. Holzknecht and Rieder, and there only the fluoroscope is used because they can palpate the viscera which they examine and see the changes which take place under palpation and massage.

To illustrate: a woman was brought into one of these clinics complaining of pain in the upper region of the descending colon. The physician who examined the woman could feel upon examination a hard mass. A roentgenogram was taken, and the bismuth was seen to meet with some obstruction. The woman was then examined by means of the fluoroscope. They massaged that region during the examination, and in a few seconds the obstruction disappeared and the bismuth passed through. It was found to be nothing more than a nervous spasm in a neurotic woman which caused the obstruction in the bowel. The same thing may occur in the condition that has been described to-night, and it may not be a kink, but simply a spasm. Therefore, one should beware of the radiographic plate in diagnosis of pathological conditions of the intestines. One should always use the fluoroscope, and then a mistake is not so likely to be made.

Dr. F. Gregory Connell, Oshkosh, Wisconsin: I did not expect to be called upon to take part in this discussion. However, as I have been asked to do so, I will be very glad to make a few remarks on these most excellent papers.

In regard to sliding hernia, there should be a marked differentiation made between it and other herniæ, especially from the standpoint of recurrence, because if we include sliding with the other herniæ, it brings the number of recurrences much higher.

Sliding hernia used to be a great bugbear to me until I learned the method of Hotchkiss, of the Roosevelt Hospital, but which, I believe, the essayist mentioned under another name. As to the priority of the method, I know nothing. In this method the peritoneum of the sac is divided so as to make a new mesentery for that portion of the bowel that is in the sac, after which one is able to replace it within the peritoneal cavity without interfering with the blood supply. The neck of the sac may then be closed in a satisfactory manner, allowing all of the redundant parietal peritoneum to be removed, which assures one of a good result.

Regarding rotation of the cæcum, it is a very confusing subject, because there are two development changes that take place; one which might be called a migration of the ileo-cæcal junction from the left iliac region up, across, and down to the right iliac fossa; and the other, a rotation of the ileo-cæcal junction, on its long axis, which usually occurs at the location of the hepatic flexure, in which the ileum changes its route of entrance into the cæcum from above and the right, to, from below and the left, as shown in these diagrams.

We may, of course, meet with a defective development at any place in this complicated embryological maneuver.

I have seen one case of left-sided appendicitis, which was supposed to be a transposition of the abdominal viscera until a more careful study demonstrated there had not been a rotation of the ileo-cæcal junction, as shown here, and this ileo-cæcal junction had dropped back into this left-sided position with the ileum, entering from the right side instead of from the left. Arrest of development at this point, the hepatic flexure, with absence of more or less of the ascending colon, is comparatively frequent and accounts for the difficulty in finding the appendix in certain cases. I have seen one case in which there was an entire absence of the ascending colon with the ileo-cæcal junction and the appendix being located at the site of the hepatic flexure.

In regard to cæcum mobile, it is apparently a defective development. The ileo-cæcal junction, after its developmental descent from the liver, under normal conditions, is fixed to the posterior parietal wall by a peritoneal fusion of the lateral leaf of the mesocolon and sometimes, the posterior portion of the visceral peritoneum of the colon, with the prerenal parietal peritoneum, and as a result there is no mesocolon and the large bowel is fixed to the posterior wall, with the cæcum in the right iliac fossa.

With imperfect fusion of these layers of peritoneum the cæcum is more or less mobile. Why this imperfect development takes place we do not know, any more than we know why there may be imperfect fusion of the funicular process in hernia.

This lack of fusion may occur in different degrees, but it does occur, and when it does occur, what may happen?

The cæcum falls into the pelvis, an abnormal location, the terminal ileum is pulled upon and the so-called Lane's kink may result, and frequently the pericolic membrane of Jackson will be found binding part of the colon to the posterior parietal wall. This latter would seem to be a late

attempt on the part of nature to rectify its imperfection by fixing the colon and striving to bring the cæcum up out of the pelvis.

Jackson's membrane or the Lane's kink may be absent, or one or both may be present; if absent, symptoms, too, are apt to be wanting, but if present, they cause an incomplete obstruction of the bowel, either in the terminal ileum or in some part of the ascending colon. Such obstructions are distinct, and readily demonstrable at the operation table and are responsible for the symptoms.

This condition is similar to floating kidney in this respect. Floating kidney without kink of the ureter does not call for kidney fixation; but floating kidney with a resultant ureteral obstruction calls for relief of the obstruction, with kidney fixation, in order to prevent a recurrence of the ureteral kink. The same applies to mobile cæcum. If there is no obstruction, no surgical measure is called for, but mobile cæcum with intestinal obstruction demands correction. If the ileal kink is merely straightened out, or the pericolic membrane merely divided or removed and nothing more is done, it is imperfect or incomplete treatment, because no attempt has been made to remove or rectify the cause of these conditions.

Results of a condition, and not the condition itself, have been attacked, adhesions have been separated which may form again. Jackson reports a case in which the pericolic membrane had not reformed when the abdomen had been opened a second time, but it seems reasonable to suppose that a certain proportion would recur. In these cases it seems we must do something more than merely relieve the obstruction *per se*, and fixation of the cæcum may be indicated.

As to the method of fixing the cæcum, the plan of Wilms is objectionable, or is said to be by Russell Fowler, because a layer of parietal peritoneum is brought over the caput of the cæcum, which is not normal. Therefore, Russell Fowler has modified the method and leaves the end of the cæcum free by anchoring the colon in a pocket of parietal peritoneum.

I wish I could say something about the diagnosis that would be of interest, but I cannot do so. I was disappointed to see that there was no neurologist to take part in this symposium, as the preliminary announcement stated. He is the important consultant that we need in a consideration of this class of cases to-day. The experience of most of us will not permit of our speaking of remote results.

Dr. Jacob Frank: When I came to the meeting this evening I did not know very much about Lane's kink, nor about movable cæcum, and, after listening to all of the brilliant remarks that have been made, I am still more in doubt. It reminds me of a discussion that the gynecologists had about the uterus years ago, particularly as to its anatomical position, and they fought for years and years, and I do not believe they know yet, and in our efforts as surgeons to understand what we are talking about we have first got to understand the normal position of the cæcum, and nobody has told us that to-night. If we could relate our experiences, it would be far better than trying to discuss where the cæcum actually belongs. We have heard to-night that the cæcum has been away down almost to the knees, in a sliding hernia, without causing any symptoms except that the man was troubled with a large hernia. I have seen such cases myself, have reduced the hernia, and have followed these cases for twelve or more years, and there has been no trouble from the cæcum. I am not going to tell you where the cæcum ought to be, or where it ought not to be, but my experience has been that a fixed cæcum is far worse than a movable one.

Dr. M. L. Harris: I want to say a word with reference to what Dr. Connell has said, namely, he thought the Jackson's membrane was an attempt on the part of nature to fix the movable cæcum. I do not think there are any facts to bear out that statement. Most movable cæci have no adhesions about them. You can move them about like you can the small intestine. Another peculiarity is that the membrane almost always misses the cæcum itself. It does not extend over the cæcum. It stops at the free part of the cæcum. You find a beautiful membrane covering all the ascending colon until it binds together every pouch of the colon, and the end of the cæcum will usually be perfectly free from the membrane.

Dr. F. Gregory Connell, Oshkosh, Wisconsin: The point Dr. Harris has brought out is perfectly true. That the cæcum is not involved in the adhesion is in accordance with embryological facts. The adhesion which normally should form the blending between the parietal and visceral peritoneum fixes the cæcum at a point just where the Jackson's membrane is usually found, and the cæcum itself is freely mobile. The Jackson's membrane does not occur in every case, but when it does occur, it occurs at the location of the normal blending, which is not at the cæcum, but at the colon.

Dr. Daniel N. Eisendrath (closing the dis-

cussion on his part): There are a few points in connection with the paper of Dr. Morf that I wish to speak of before closing the discussion on my own paper.

In dealing with the sac, I have had the greatest difficulty with that, and owing largely to the fact that one is not able to ligate the sac as high as possible. I have tried to make every effort to do as thorough an operation as he mentioned, but in trying to separate the peritoneum I have encountered a terrific hæmorrhage sometimes, especially in the last case I operated upon, from the arteries where the mesentery was attached.

I had an interesting case of sliding hernia of the cæcum last February. The young man, in whose case a diagnosis had been made of appendicitis, had had a hernia for a good many years. He was seized suddenly with pain in the right iliac region, and following this the hernia came out and would not go back again. I operated the same night, and found a hernia which showed signs of inflammation, and also a small loop of the intestine which became strangulated. I have made it a rule in all these sliding hernias of the cæcum, in addition to doing an operation for the hernia itself, to remove the appendix. In regard to the discussion on movable cæcum, I have tried to make my position clear, which is that of the citizens from Missouri, I am still willing to be shown. Personally, I have at the present time, doubted whether movable cæcum could possibly produce any pathological sequelæ sufficient to give rise to clinical symptoms, but owing to the fact that the Germans seem so positive about it, and they are such excellent men, whose statements we cannot doubt, but who are undoubtedly overenthusiastic, I thought it would be profitable for us to discuss this question and to review our own experiences.

In regard to the question raised by Dr. Croftan and by Dr. Ochsner, it is true that many times in operating in the abdomen we find movable cæcum without symptoms. A movable cæcum may be an embryological anomaly or a visceroptotic anomaly, which may have existed for a long time, and suddenly it becomes changed and gives rise to symptoms. There can be no question about that portion of it, and that a certain proportion of them become pathologic conditions.

With reference to the diagnosis, I do not believe it is quite as uncertain as a great many would have us infer. The great difficulty is to determine how much these symptoms are due to neurasthenia and how much are due to the genuine pathological condition. That seems to be the crux of the whole situation and it can only be solved by future observations and such discussions as we have had to-night.

In regard to the various operations substituted for cæcopexy, or ileosigmoidoscopy, such as Lane suggested, we ought to go slow. I have heard of a case the past week where ileosigmoidoscopy had been performed on the basis of a diagnosis having been made of Lane's kink, and the woman has had a most disagreeable diarrhea, the contents of the small intestine having escaped into the large intestine much more quickly than they ought to have done, and perhaps it may mean the undoing of the previous operation.

In regard to Jackson's membrane, I have seen it in fixed and movable cæci, and cannot agree with Dr. Harris or with Dr. Connell. I have demonstrated its presence to a number of gentlemen where it covered the entire colon and cæcum down to the appendix. My principle in these cases of the Jackson's membrane with movable cæcum is to leave them alone and watch them.

Dr. Morf (closing the discussion): Regarding Dr. Cubbins' remarks with reference to the nomenclature of these sliding hernias and saying that they should be called hernia of a sliding viscus, I think the French term hernia by sliding or by gliding is much more correct, but the term sliding hernia in English has been used.

As to the question whether in sliding hernia of the sigmoid the mesentery was attached outside the abdominal cavity, that can be answered affirmatively. Six or seven years ago I saw a patient operated on in whom the lower part of the sigmoid was inside the left inguinal hernia, and the mesentery of the sigmoid had been transplanted outside of the abdominal cavity.

As to Dr. Ochsner's remarks in regard to the diagnosis of this condition, what he has said is very true. Where we find an old hernia that is irreducible, at least in part, we can suspect that a hernia of this kind exists. In that, probably, the obstacle in returning it to the abdominal cavity is a transplantation of the mesenteric attachment.

With reference to the Hotchkiss method of operating, I have not seen it mentioned in the literature, but I am glad that Dr. Connell has brought it to my attention.

# ABSTRACTS OF CURRENT LITERATURE

## DEPARTMENT OF SURGERY

UNDER THE CHARGE OF

FREDERIC A. BESLEY, M. D.


GEORGE E. BEILBY, M. D. — WM. R. CUBBINS, M. D. — AIMÉ PAUL HEINECK, M. D.
J. S. EISENSTAEDT, M. D. — FREDERICK G. DYAS, M. D. — B. J. O'NEILL, M. D.
JOHN A. WOLFER, M. D. — JAMES F. CHURCHILL, M. D. — H. A. POTTS, M. D.


**The Effect of Extensive Resections of the Small Intestine.** JOSEPH MARSHALL FLINT. *Johns Hopkins Hosp. Bull.*, xxiii, No. 255, 1912.

After a comprehensive study of the effect of extensive resections of the small bowel in the surgical laboratory of Yale University, the author has come to the following conclusions:

"1. As much as 50 per cent of the total small intestine in dogs may be removed without fatal results. The animals may gradually return to a condition of practically normal weight and metabolism when maintained on favorable diet under good conditions. Resections of 75 per cent and even more of the small intestine may be survived, but such animals are not liable to show a true recovery, i. e., a return to normal weight with the establishment of a good compensatory process.

"2. At first, the animals suffer from a severe diarrhœa, ravenous thirst, and appetite, and loss of weight, from which they gradually recover until conditions may return to those of a normal animal. They remain, however, extremely sensitive to unfavorable conditions of diet and living.

"3. Metabolic studies on such animals show that there is a marked increase in the excretion of the nitrogenous, fatty and carbohydrate elements of the food. The elimination may reach 66 per cent of the diet content. After compensation is established on a rich, easily assimilated diet, digestion goes on as in a normal dog, except for an increase in the amount of intestinal putrefaction, as indicated by the amount of indican in the urine. An increase of the amount of fats in the food may lead to an increased elimination of nitrogen and fats to a point about 25 per cent above the normal after the compensation is established. The carbohydrates, on the contrary, are absorbed to a degree considerably above normal after the compensation is established.

"4. The compensatory process consists in a hypertrophy as well as hyperplasia of the remaining portion of the small intestine. There is no regeneration of either the villi or the crypts. Computation makes it probable that in favorable cases approximately the original epithelial area of the intestine is restored by the hypertrophic process.

"5. As in animals, about 50 per cent of the small intestine may be resected without much danger of serious consequences in the majority of cases. The resection of smaller amounts may, however, be followed by severe metabolic disturbances, and even inanition and death. Human cases behave in general like the animals. They show similar metabolic disturbances. In one case there was distinct evidence of a compenstaory process. No regeneration or hypertrophy has ever been reported in a human case. There are over fifty-eight cases reported in the literature where over 200 cm. of the small intestine have been resected. The mortality is 16 per cent, which is probably much lower than it should be, owing to the greater probability of successful cases finding their way into the literature.

"6. The metabolic disturbances in human cases bear no definite relationship to the amount of small intestine resected. Five resections of over 400 cm. have recovered, while death from inanition has resulted from the resection of 284, 289, 300 and 350 cm., respectively. Profound digestive disturbances have resulted from the removal of 192 and 204 cm. of ileum. In human cases, factors like difficulties in measurement, the pathological condition, the total length of the intestine, and the resistance of the patient undoubtedly modify the result, and explain the apparent discrepancies between the amount of intestine resected and the subsequent metabolic disturbances.

"7. The prognosis in human cases should be guarded. Apparently successful resections may, for lack of suitable compensation, succumb ultimately to a slow process of inanition.

"8. The experiments and the series of human cases emphasize the specific function of the three segments of the gastro-intestinal tract. Neither the stomach nor colon is able to compensate for the loss of large portions of the small intestine.

"9. Resection of the human intestine is almost never an operation of choice. The surgical rule has been, and will continue to be, a resection of the minimum amount allowed by the pathological conditions. From the metabolic studies, it would seam wise to give these patients a rich and easily assimilated diet, poor in fats and relatively rich in carbohydrates."

**Operative Injuries of the Thoracic Duct, Their Importance and Treatment** (Die operativ entstandenen Verletzungen des Ductus Thoracicus, ihre Bedeutung, ihre Behandlung). D. G. ZESAS. *Deut. Zeit. für Chir.*, iii, 4, 1912, s. 14.

The author gives the anatomy of the thoracic duct in detail, in connection with the anomalies occasionally found. Special emphasis is laid upon the fact that in several published cases of ligature of the thoracic duct, no special disturbance followed because of the development of a collateral circulation of the lymphatics with the venous system. Forty-nine cases described by various authors are reported in detail. Four methods of dealing with operative injury of the thoracic duct are discussed.

FREDERICK G. DYAS.

**Varicocele and Its Operative Treatment** (Om Varicocele och dess Operativa Behandling). GUNNAR NILSON. *Nord. Med. Arkiv*, i, (Kirurgi), h. 1, No. 1, 1912.

This is a long article in the Swedish tongue which is most exhaustive, but contains not a great deal that is new. It is followed by a short resumé of about five pages in German. The work is based on sixty-one cases operated, of which forty-two were seen from three months to six years after the operation. Of these, thirty-eight showed complete recovery, three were remarkably better, and one, after seven months, still had a thrombus, which was causing some pain. The operation which he performed was not essentially different from that ordinarily resorted to in these cases, except that the testicle was suspended from the aponeurosis of the internal oblique.

**Experiments on the Relation of the Staphylococcus Pyogenes Aureus to Infectious Thrombophlebitis.** (Experimentelle Untersuchungen über die Beziehungen des Staphylococcus Pyogenes Aureus zur infektiösen Venenthrombose). RUDOLPH RUBESCH. *Beitr. zur klin. Chir.*, lxxv, h. 3.

It has been fairly well established that postoperative thrombophlebitis is the result of bacterial infection. In 1902 Baumgarten demonstrated that the blood held in a vessel between two ligatures would not coagulate, but would remain fluid for weeks, provided that there was no local infection. Heller found that thrombophlebitis could be experimentally produced not only by living cultures of bacterium coli, but by dead bacteria and their toxines as well. Heretofore thrombophletibis has been ascribed first, to disease of the vessel wall (phlebitis), second, to alterations of the lumen (varicosity), and third, to alterations of the blood and blood stream.

The aim of Rubesch's work was to determine to what extent the staphylococcus pyogenes aureus was involved in the causation of thrombophlebitis, both as regards the action of living and dead organisms and their toxines. To this end he made an exhaustive series of experiments on animals from which the following conclusions are drawn:

Living staphylococci are capable of producing thrombophlebitis This is true in lesser degree of dead bacteria and of toxines which produce this result under certain condition only. Living germs are constant in their action when applied to a vein. When injected into the lumen of the vessel, it was necessary to retard the blood stream before coagulation would set in. Streptococci and colon bacilli differ from staphylococci, in that, under similar conditions they can produce coagulation when the blood stream is but slightly retarded. The local action of staphylococcus toxines was such that when applied to a vein or injected into the lumen, there was no clot formed until complete stasis had been secured. Dead bacteria in the intensity of their action occupy a position between living organisms and toxines. While it is not necessary for the blood stream to come to a complete standstill, as in the case of the toxines, yet a considerable retardation is necessary before coagulative changes occur. The conclusion is drawn that the toxines are the active principles necessary for the production of thrombosis, and that the action of living germs is more intense owing to the greater amount and virulence of the toxines.

**The Pathogenesis of Appendicitis** (Zur Pathogenese der Appendizitis). MILOSLAVICH. *Wien. klin. Woch.*, 1912, xxv, 442.

This discussion is taken up from two standpoints: The first as to the predisposition to appendicitis in cases of lymphatism, and the second as to the indications and the presence of lymphatism in cases of appendicitis. Under the former proposition he finds that in patients suffering from lymphatism the appendix is much longer than in the normal individual, and as a consequence more apt to be kinked and turned. There is also a distinct funnel-like opening from the cæcum into the appendix. There is a hyperplasia of the lymphatic tissue, with a diminished amount of muscular tissue, which predisposed distinctly to distention of the organ from stagnation. In regard to the second proposition, he found that appendicitis is very frequently accompanied by the status lymphaticus, and some times with persistent thymus. He speaks of this as lymphatic appendicitis.

In regard to those cases which show pain in the ileocæcal region, and which, on operation, show no definite signs of appendicitis, he has found that the appendix is not normal, but that there is a hyperplasia of the lymphatic apparatus and there is a highly developed mesenteric plexus, which he thinks will bring about an increased irritability of the appendix by predisposing perhaps to a distention of the muscular wall. He thinks that the lymphatism will explain the presence of appendicitis in families. He notes that, of course, this combination of lymphatism and appendicitis can only be applied to a limited number of cases.

# BOOK REVIEWS

THE SEXUAL LIFE OF WOMAN. By E. Heinrich Kisch, M. D., Professor of the German Medical Faculty of the University of Prague. Authorized translation by M. Eden Paul, M. D. New York: Rebman Company, 1911.

In this work the sexual life of woman is considered both in relation to the female genital organs and in relation to the feminine organisms as a whole; in relation both to the physical and the mental development of the individual; and in relation alike to the state of health and to the processes of disease. Based upon clinical evidence and practical experience the book is frankly offered as a contribution towards the solution of the sexual problem, nowadays recognized as one of supreme importance.

The author finds his subject naturally divided by three great landmarks; the onset of menstruation — the menarche; the culmination of sexual activity — the menacrue; the cessation of menstruation — the menopause. These several sexual epochs are differentiated by characteristic anatomical states of the reproductive organs, by the external configuration of the feminine body, by functional effects throughout the entire organism, and finally by pathological disturbances of the normal vital processes.

While much of the matter comprising this volume may be found in the various text-books of gynecology, yet many things of far-reaching importance in relation to the physical, mental, and social well-being of women are incorporated here in a detailed exposition. Thus, the sexual impulse, copulation, fertility, sterility, the prevention of conception, the determination of sex, and sexual hygiene, topics not emphasized in general texts, are subjects given intimate discussion by Kisch. On the other hand, such subjects as pregnancy, parturition, and lactation are little more than referred to since they have been adequately covered in the numerous works on obstetrics.

In the discussion of the question of social hygiene, Kisch is an ardent advocate of education for both the young girl and the boy. He regards it as the duty of humanity to educate women for maternity from the youth upward, "so that she is in every way fitted for the supreme duty of her sexual nature." He insists, however, that sexual enlightenment must not be made an excuse for the unchaining of sensibility and deplores the too frequent appearance of the modern *demi-vierge*. While not agreeing with the misogynist, Schopenhauer, nor with von Hartman in their radical views, he quotes from L. von Stein; "the woman who spends the whole day at a desk, in the law courts, or in a house of assembly, may be a most honorable and most useful individual, but she is no longer a woman, she cannot be a wife, she cannot be a mother. In the condition of our society, the emancipation of woman, is in its very nature the negation of marriage."

Woman is granted the right of refusing marriage, but not the right to deny maternity, having accepted marriage. "Such professions only are suitable to a woman as do not entail a restriction of the sphere of her reproductive activity, a hindrance to her principal duty, that of maternity, an interference with the discharge of her obligations to husband and children, or a diminution of her domestic value and an evasion of her responsibilities in family life." The author is not, however, greatly alarmed by the teachings of the more radical advocates of woman's rights, since, he argues, though she may try to avoid her natural responsibilities, she is ever unable to escape from her femininity.

CAREY CULBERTSON.

MANUAL OF SURGICAL TREATMENT. By Sir W. Watson Cheyne, F. R. C. S., and F. F. Burghard, M. S., F. R. C. S., Revised edition. Vol. I. Philadelphia and New York: Lea & Febiger, 1912.

This is the first volume of the revised edition of this comprehensive work on surgery. Volume I treats of general surgical diseases, including inflammation, suppuration, ulceration, gangrene, wounds and their complications, infective diseases and tumors, and deformities; with an appendix upon the administration of anæsthetics by Dr. Silk, and examination of the blood by Dr. W. D'Este Emery.

Besides the editors, Dr. Silk, Dr. D'Este Emery, Dr. Arthur Whitfield and Mr. A. D. Reid have collaborated in the preparation of the present edition.

UROLOGY. By Ramon Guiteras, M. D. Vols. I and II. New York and London: D. Appleton & Co., 1912.

In publishing this work on urology, Dr. Guiteras has deviated somewhat from the usual type of text-book on this subject, including all the diseases of the urinary tract, both medical and surgical, in men and in women. The book is published in two volumes, and is amply illustrated. The author has given a great deal of attention to the small details of urology, such as the methods of examining discharges, urine, and blood, the technique employed in using the apparatus, and special instruments required in this field of surgery.

Cystoscopy and ureteral catheterization are carefully considered and well illustrated. He also

includes various functional kidney diagnostic methods.

A chapter on urological therapeutics is given, which contains much practical advice on diet, exercise, and water diet in urology, the use of water in the form of baths, vaginal irrigations and the use of water per rectum.

A chapter on special urinary symptoms is well written and classified, containing references to the various disturbances of micturition, changes in the amount of urine, and changes in the character of the urine.

The various pelvic lesions in women which are provocative of vesical disturbances are briefly considered and well classified. The section on the kidney contains both medical and surgical lesions. The operative technique of kidney and ureteral surgery is well illustrated and much attention is given to this subject.

In the chapter on diseases of the prostate, we can see the author's painstaking attention to detail. His nonoperative treatment of prostatic lesions is well written and contains much information and many valuable suggestions. Guiteras favors the suprapubic method of prostatectomy.

Acute and chronic gonorrhœa with their resulting complications are elaborately considered. Much practical information both as regards diagnosis and treatment of gonorrhœa in the female is contained in another chapter.

The author has also added a chapter on syphilis in which he considers the treatment in detail, giving special reference to the use of salvarsan and its result or effects on the spirocheta and the Wasserman reaction. This chapter has been brought up to date by an addition of our most recent diagnostic agent in the domain of syphilis, namely, the Noguchi luetin test.

In giving the treatment of tumors of the bladder, the latest addition in this field of surgery is noted by a brief reference to the use of high frequency current in the treatment of papillomas of the bladder.

Guiteras has given us a well written, profusely illustrated and thoroughly up-to-date work on the subject of urology. HERMAN L. KRETSCHMER.

DISEASES OF THE NOSE AND THROAT, COMPRISING AFFECTIONS OF THE TRACHEA AND ŒSOPHAGUS. By St. Clair Thomson, M. D., F. R. C. P. (Lon.), F. R. C. S. (Eng.). New York: D. Appleton, & Co., 1912.

The author, a prominent English laryngologist, discusses thoroughly and completely in a fair and discriminating way the diseases of the nose and throat. He pays particular attention to the methods of examination; also giving ample illustrations of most salient points — a very desirable feature of this work.

Treatment in general, as well as the instruments used for same, receive ample space and are carefully covered.

The anatomy, physiology and pathology receive their proportionate share in the work as their importance warrants.

The illustrations are all good, some particularly so, such as the one on transillumination of the antrum, also the radiographs of the frontal sinus and sphenoidal sinus.

The section devoted to the diseases of the nose is handled in a very masterly way — the chapter on hay fever is particularly good. The chapter on diseases of the accessory sinuses is worthy of the time of any specialist or general practitioner.

Operations are described in a clear terse style and are not encumbered by unnecessary details.

In fact the work from cover to cover is excellent for student, general practitioner or specialist.

H. P. BAGLEY.

PRACTICAL GYNECOLOGY. By E. E. Montgomery, M. D. Fourth Edition. Philadelphia: P. Blakiston's Son & Co., 1912.

This book in the fourth edition is thoroughly revised by omitting from and adding to the original text. In this edition, the medical aspect of gynecology has been more definitely emphasized which argues well for the future of gynecology as a specialty.

## BOOKS RECEIVED

SURGICAL CLINICS OF JOHN B. MURPHY, M. D. Vol. I, No. 2. Philadelphia and London: W. B. Saunders Company, 1912.

CYCLOPEDIA OF AMERICAN MEDICAL BIOGRAPHY. By Howard A. Kelly, M. D. Philadelphia and London: W. B. Saunders Company, 1912.

DUODENAL ULCER. Second Edition. By B. G. A. Moynihan, M. S., F. R. C. S. Philadelphia and London: W. B. Saunders Company, 1912.

TUMORS OF THE JAWS. By Charles L. Scudder, M. D. Philadelphia and London: W. B. Saunders Company, 1912.

AUGUSTUS CHARLES BERNAYS. A Memoir. By Thekla Bernays. St. Louis: C. V. Mosby Company, 1912.

SURGERY OF THE FACE. By John B. Roberts, A. M., M. D. New York: William Wood & Company, 1912.

A SURGICAL TREATMENT OF LOCOMOTOR ATAXIA. By L. N. Denslow, M. D. London: Baillière, Tindall & Cox, 1912.

LATERAL CURVATURE OF THE SPINE AND ROUND SHOULDERS. By Robert W. Lovett, M. D. Philadelphia: P. Blakiston's Son & Co., 1912.

A MANUAL OF SURGICAL TREATMENT. By Sir W. Watson Cheyne, F. R. C. S., and F. F. Burghard, M. S., F. R. C. S. Vol. II. Philadelphia and New York: Lea & Febiger, 1912.

INDEX OF DIFFERENTIAL DIAGNOSIS OF MAIN SYMPTOMS. Edited by Herbert French, M. D. Bristol, England: John Wright & Sons, Ltd., 1912. New York: Wm. Wood & Co.